Saskatchewan
Agriculture
and Food

ADF

AGRICULTURE DEVELOPMENT FUND

FINAL REPORT

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ADDITION TO SCOPE REQUEST FOR EQUIPMENT FOR ESSENTIAL OIL EXTRACTION

Funded by: The Agriculture Development Fund

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5004E/5005E

Research Report

Equipment for Essential Oil Extraction

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1. Abstract/Summary

The production of crops grown specifically for essential oil use has increased in Saskatchewan as producers seek higher value crops such as, caraway, dill, and coriander. While often grown for seed under contract, the possibility of extracting oils from screenings or from foliage of spice crops, as in the case of dill or caraway screenings or dill foliage, can offer increased revenue opportunities.

Previously, only laboratory-scale essential oil extraction could be carried out in Saskatchewan, except for the Maple Ridge Farms (MRF) large-scale seed extractor that can extract oil from large seed quantities; however, its status is in limbo. PAMI has been requested to process large quantities of screenings and simple runs on small seed quantities, indicating the demand for use of a pilot-scale essential oil extractor.

PAMI requested and received funding support from the Agriculture Development Fund of the Saskatchewan Department of Agriculture and Food to design and fabricate a pilot-scale portable essential oil extractor with seed and foliage capability for the purposes of toll processing and on-site use by producers. A side benefit of this project was the development of additional in-province expertise which can be accessed by fledgling entrepreneurs in the essential oil industry who wish to develop their own extraction capability.

The pilot-scale oil extractor's major components consist of a propane boiler (10 hp, 15 psi), seed and foliage extractor kettles, cooling condenser, and oil/water receiving separator which is all enclosed within a 7 ft x 14 ft mobile trailer. The extractor's design does not require a steam engineer to operate and is intended to be pulled by a common farm truck.

In July of 2007, PAMI finished the final successful commissioning of the mobile pilot-scale oil extractor by testing its ability to extract oil from poplar leaves (using the foliage extractor) and caraway screenings (using the screen extractor). The pilot-scale oil extractor is now available for toll processing at PAMI's Crops Processing Development Centre and within the next year, PAMI plans to make it available to users at their location once more detailed information is known about its operating parameters in a wide range of materials (i.e. dill, caraway seed, fir needs, poplar leaves, and rose flowers).

2. Introduction

The production of crops grown specifically for essential oil use has increased in Saskatchewan as producers seek higher value crops, such as, caraway, dill, and coriander. While often grown for seed under contract, the possibility of extracting oils from screenings or from foliage of spice crops, as in the case of dill or caraway screenings or dill foliage, can offer increased revenue opportunities.

Added opportunities exist to extract valuable oils from other herbs, spices, and wild crafted plants. Volumes of material often do not justify construction of an extraction plant initially and extraction-operating parameters need to be determined. Some types of raw material can only be produced in very small quantities and an extraction plant is needed at the source.

Previously, only laboratory-scale essential oil extraction could be carried out in Saskatchewan, except for the Maple Ridge Farms (MRF) large-scale seed extractor that can extract oil from large seed quantities. The MRF extractor's status is now in limbo due to the financial failure of Maple Ridge Farms. A number of obstacles prevent its use for test runs on small quantities of seed. The extractor requires extensive setup work (approximately $15,000 cost) each time it is used, changes to enhance operational safety (approximately $10,000 cost), and has an hourly utilities cost of $180 while running. It also needs at least 3 tons of material to fill the system, and up to 20 tons of material to obtain stable operating conditions. The set-up and operating cost issues can be addressed, but the volume issue is inherent in the design.

The Prairie Agricultural Machinery Institute (PAMI) has been requested to process large quantities of screenings and simple runs on small seed quantities, indicating the demand for use of essential oil extraction equipment. There are also opportunities for wild crafted product extraction in the north. A system was needed that could be used for testing and to assist in design of a suitable plant for that location.

Prior to the commencement of the project, stakeholder input suggested that low cost and/or used equipment could be easily obtained and would meet the project requirements. PAMI's budget was based upon that input; however, once the project had been initiated and detailed research and design was conducted, it became obvious that the equipment and design requirements were considerably higher than anticipated. As a result, it was estimated that $31,800 ($16,500 in materials and $15,300 in labour) of additional funds would be required to properly complete the project. The extra funding was requested from ADF and ADF agreed to provide it.

3. Methods

3.1 Previous Oil Extractors and Additional Design Criteria

The extractor, designed and fabricated by PAMI, was loosely modeled after the Mobile Steam Distillation Unit developed by the Alberta Natural Health Agricultural Network (ANHAN) with two distinct exceptions. The PAMI oil extractor was planned to contain:

- Kettle for foliage or larger piece material distillation.
- Small continuous flow unit for oil extraction from seeds.

A detailed examination of the ANHAN unit and purchasable alternatives was performed. The ANHAN unit had some need for improvement:

- It was not insulated; therefore, external surfaces were at 100°C and could easily cause burns.
- There were problems with loading and unloading materials.
- It was limited in condensing capacity.
- It was not easily cleaned; hence, contamination could potentially occur between different products.

The information from the ANHAN unit was used as design criteria in addition to the following specifications:

- The unit would be mobile and stored in a weather tight system where it can be maintained and stored outdoors if needed.
- The boiler would be low pressure to avoid the need of a fifth class steam engineer to operate it.

3.2 Objective

The objective of this project was to design and fabricate a pilot-scale portable essential oil extractor with seed and foliage capability. It was primarily planned to be used at the PAMI's Crop Processing Development Centre and on farms for research into the optimization of essential oil extraction, and for toll processing of raw material on an ongoing basis for small scale producers.

3.3 Project Changes

A number of minor items were noted and required the project to be redirected from its original proposal. These items were:

- To reduce the complexity of the system, the 4 hp 15 psi electric boiler was modified to a 10 hp, 15 psi propane boiler complete with feed water pump and flow restrictor.

- The unit can be powered by readily available single-phase power or a mobile 4 kW electric generator for field use.
- The initially planned ISO shipping container was changed to a common tandem axle enclosed trailer that can be pulled by a typical farm truck.

4. Results

4.1 Equipment

The major components of the oil extractor are:

- Seed Extractor – PAMI Designed and Fabricated
- Foliage Extractor – PAMI Designed and Fabricated
- Boiler - Purchased
- Condenser - Purchased
- Distillation Vessel - Purchased
- Trailer - Purchased

4.1.1 System Schematic

The simplified system schematic is shown in **Figure 1**. Although the seed/foliage extractor is shown as one unit, it actually is two distinct units where the inlet and outlet hoses can be moved from either extractor. The entire system is located in a 7 ft x 14 ft mobile trailer (**Figure 9**).

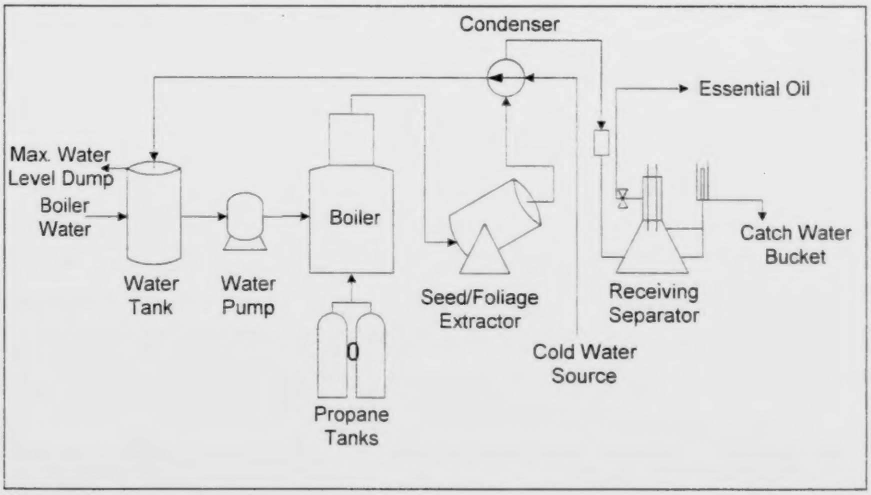

Condenser
Essential Oil
Max. Water Level Dump
Boiler Water
Boiler
Water Tank
Water Pump
Seed/Foliage Extractor
Receiving Separator
Catch Water Bucket
Cold Water Source
Propane Tanks

Figure 1. System Schematic.

4.1.2 Seed Extractor

The oil extraction unit for seeds is shown in **Figure 2**. The seed extractor has a capacity of 7.09 ft^3 and has a screen that rotates at 12 rpm. The entire unit can pivot to permit ease of cleaning and loading. The barrel of the unit is insulated to reduce potential burning hazards and has two connection ports, one for steam to enter the extractor and a second for exiting steam and oil. A manifold distributes steam through the seed bed, ensuring consistent distribution.

Figure 2. Seed Extractor.

4.1.3 Foliage Extractor

The extraction system for foliage is shown in **Figure 3**. It has capacity of 9.3 ft^3; however, it does not rotate like the seed extractor. Similarly to the seed extractor, the foliage extractor barrel can pivot to permit ease of cleaning and loading and is insulated. The inlet and exhaust lines from the seed extractor can be disconnected and connected to the foliage extractor. Only one extractor can be operated at a time.

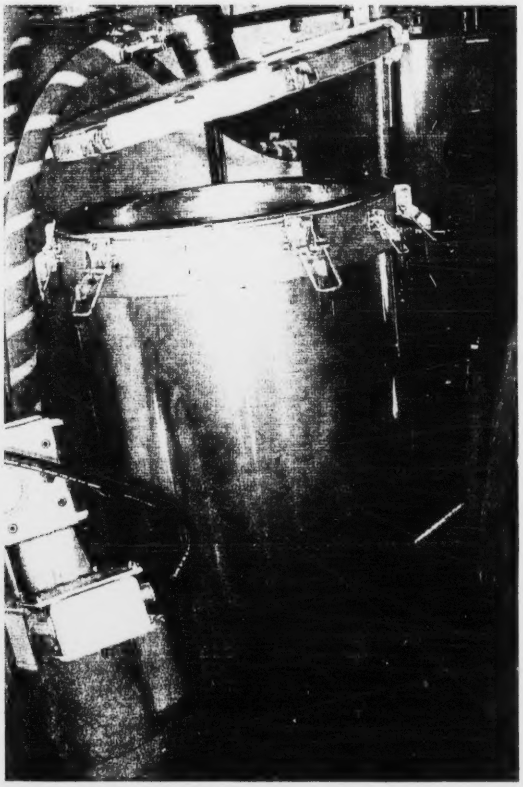


Figure 3. Foliage Extractor.

4.1.4 Boiler

The 10 hp – 15 psi boiler specifications are noted in **Appendix I** and the unit is shown in **Figure 4**. The boiler is fueled with propane; however, the feed water pump is powered with 120V single-phase electric power. The propane tanks are located at the front of the trailer and ramps assist with rolling the tanks into their storage position as shown in **Figure 5**.

The tank that supplies water for the boiler (**Figure 6**) needs to be initially filled during the extraction process. During extraction, the water cooling the condenser is transferred into the water tank and if the water tank is too full, then water is allowed to exit the tank.

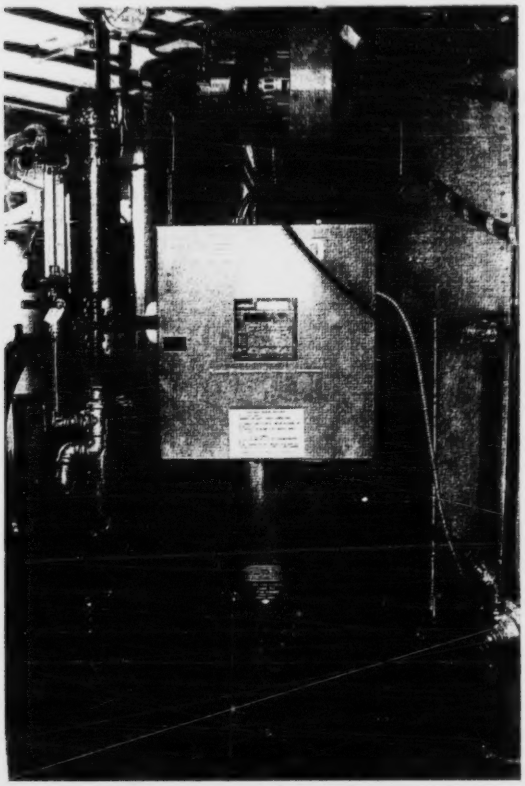


Figure 4. 10 hp – 15 psi Fulton Propane Boiler, Feed Water Pump, and Flow Restrictor.

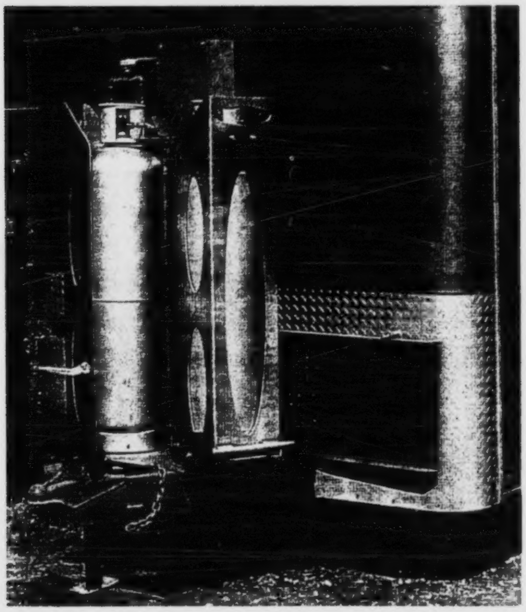


Figure 5. Dual Propane Tanks and Ramp.

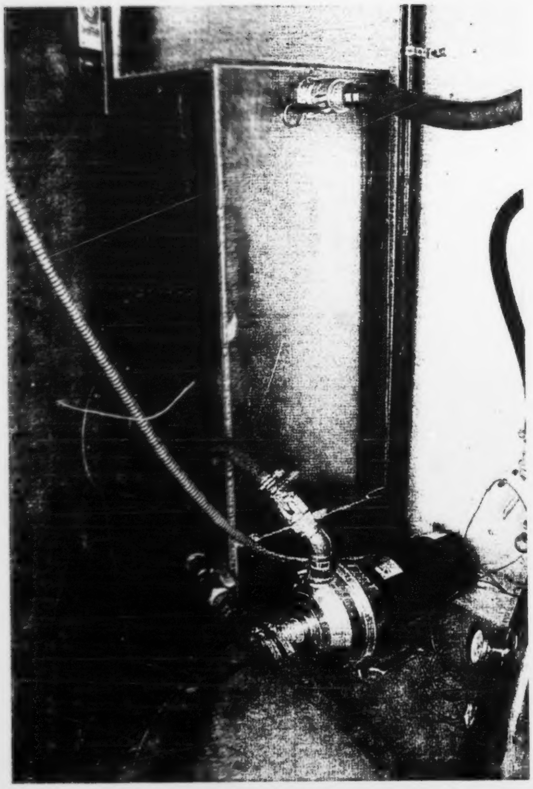


Figure 6. Boiler Water Tank.

4.1.5 Condenser

The condenser that separates the oil from the steam/oil mixture is the Alfa Lavel Model M3-FG condenser (**Figure 7**). Specifications for it are shown in **Appendix II**. The desirable feature of this condenser is that its condensing capacity could be easily changed by increasing or decreasing the number of plates. This particular feature should allow for the future extraction of a wider variety of materials which could not be anticipated during the design of the extraction system.

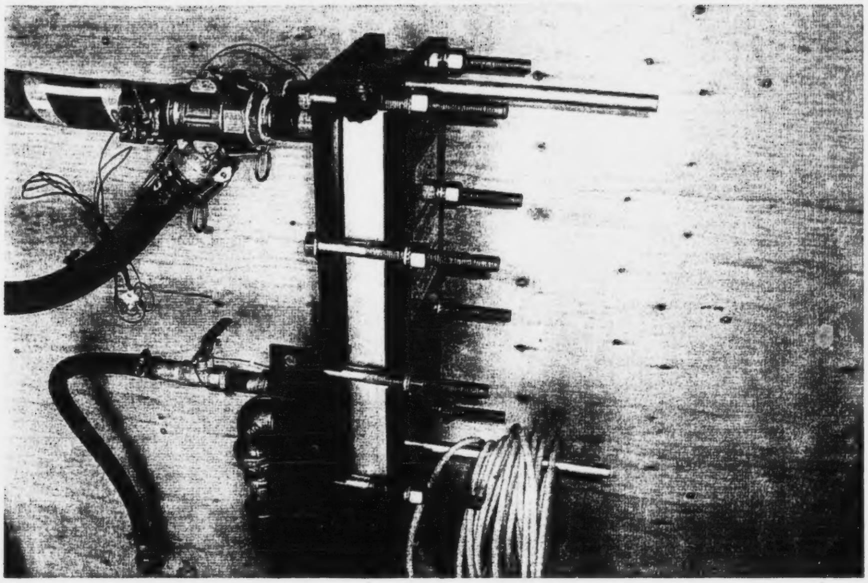


Figure 7. Condenser.

4.1.6 Receiving Separator

The receiving separator that separates the oil from the water after the steam/oil mixture is condensed is shown in **Figure 8** and additional specifications may be found in **Appendix III**. The oil/water mixture from the condenser enters the triangular flask near its bottom and passes through a rock mixture. The increased surface area of the rock mixture allows the water/oil mixture to separate and the oil floats to the top of the water mixture. The oil then is drawn off of the top of the flask.

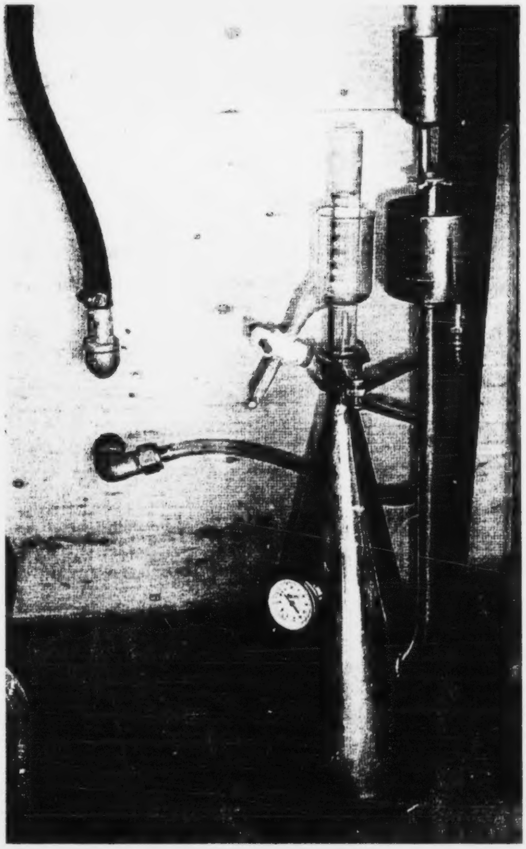


Figure 8. Receiving Separator Vessel.

4.1.7 Trailer

The trailer retaining the extraction equipment is a tandem axle 7 ft x 14 ft Royal Cargo trailer (**Figure 9**) with a gross vehicle weight rating of 8,042 lb. It has two access doors (front personnel and a rear ramp) that allows:

- Air to flow through the trailer while processing.
- Two escape routes.
- Ease of moving large containers of product via the ramp.

The trailer has been lined with plywood and additional propane tanks have been added in front of the trailer on the hitch. Specifications for the trailer are provided in **Appendix IV**.

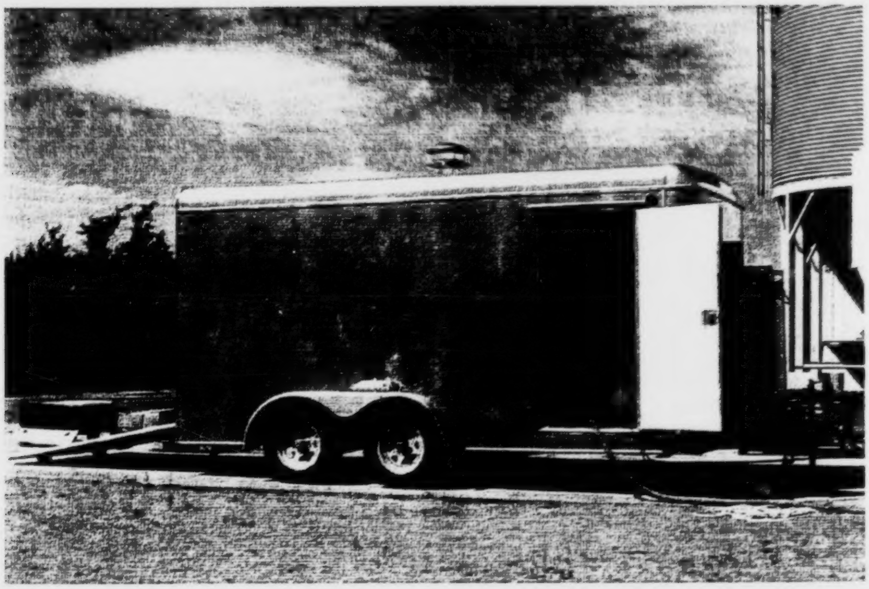


Figure 9. 7 ft x 14 ft Royal Trailer.

4.2 Commissioning Notes

During the last two weeks of June and the first two weeks of July 2007, the boiler went through a commissioning process to ensure its successful operation. The commissioning notes are found in **Appendix V**.

During the first commissioning of June 11, 12, and 13, 2007, the extraction system was operated without product to determine the capabilities of the boiler and condenser. General observations were:

- The boiler should be operated at a maximum of 5 to 7.5 psi with the steam valve at a maximum of a half-open; otherwise, the inlet to the receiving separator will overflow.
- A pinhole leak on the foliage tank was found on the bottom seam and repaired.
- The foliage tank gaskets were leaking and it was determined that the glue was not resistant to temperatures of 100°C despite its published specifications. A repair was later found.
- A small quantity of water collected in the foliage extractor during start-up because the steam condensed on the initially cool surfaces.
- The water output of the receiving separator could not overcome the line head pressure of the long "garden hose". When the hose was significantly shortened, the water flowed easily.

In July of 2007, the extractor unit was tested with poplar tree leaves and caraway seed screenings. It was noted that when processing caraway screenings, the condenser had poor capacity. The condenser was removed from the trailer and disassembled

(**Figure 10**) and caraway screenings were found between the plates, reducing the flow of the oil/steam mixture through the plates. The plates were cleaned, assembled, and reinstalled and the oil extraction from the remaining caraway was successful.

The caraway screenings entered the steam/oil mixture because of an accidental increase in the boiler output pressure. It is thought the higher pressure caused the caraway screenings (which was inconsistent material) to bubble, and become airborne in the seed extractor. It may be necessary to modify operating procedures or equipment with some very light materials to prevent this from happening.

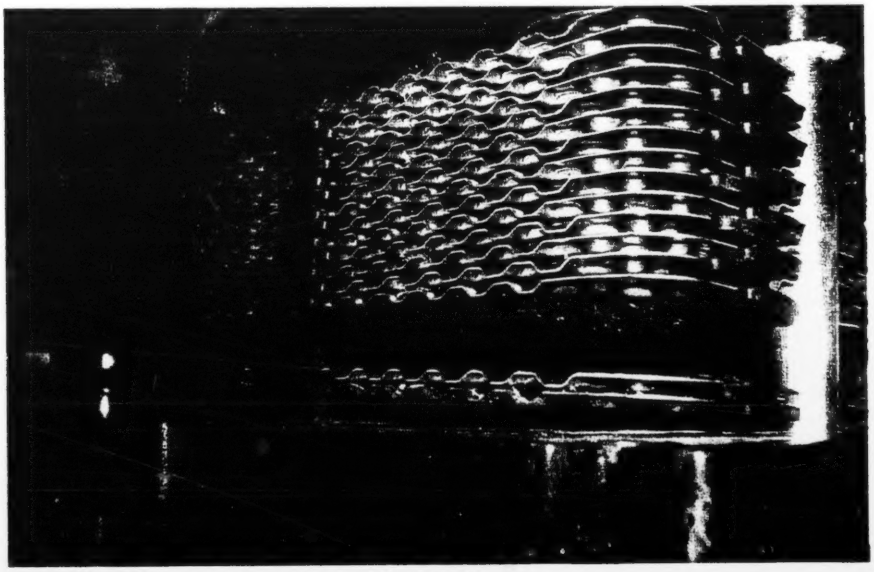


Figure 10. Caraway Screening in the Condenser.

Poplar leaves were tested in the foliage extractor as a leaf type material with no problems observed; however, it was noted that the leaves produced very little oil as balsam oil is normally recovered from the buds before they open. Once opened, the oil evaporates from the leaves.

4.3 Operating Instructions

The operating instruction of the boiler and condenser may be found in **Appendix I** and **II** respectively. It is planned that for the first year of operation that the extractor will be operated at PAMI's Crop Processing Development Centre (CPDC) building. Operation of the extractor in close proximity to PAMI, will allow PAMI personnel to observe and learn the systems unique operating characteristics and to overcome any additional challenges of operating the unit.

From the experiences learned through this first year with extracting different types of oils, PAMI plans to develop a custom operating manual that will allow the extractor's future external users to operate it themselves with minimal guidance from PAMI personnel. With each type of material there may be specific operating procedures which enhance recovery rates and improved the systems performance.

5. Conclusions & Recommendations

The goal of designing and fabricating a pilot-scale essential seed and foliage oil extractor for toll processing has been successfully achieved. The unit is currently available for toll processing at PAMI's CPDC centre and it is currently planned that within one year, once a detailed operating manual has been developed, the unit will be available on a fee-for-service basis to individual processors for oil extraction at their locations.

During August 2007, PAMI will be preparing a news release informing the general public about this new oil extraction service that PAMI will be providing. PAMI's website will be modified to include the oil extractor as a new service. During the summer of 2008, PAMI plans to exhibit the operation of the oil extractor at the annual field day of the Herb and Spice Conference. In all three extension activities, PAMI will acknowledge the funding support of the Agriculture Development Fund.

6. Acknowledgement

PAMI wishes to acknowledge the funding support provided by the Agriculture Development Fund of the Saskatchewan Department of Agriculture and Food.

Appendix I

Boiler Specifications

Specifications

10 HP

Model ICS 10

Ratings Sea level to 3000 FT. (From 0 PSIG and at 212 Degrees F)
914 M (From and at 100 Degrees C)

ICS Output	335,000 BTU/HR 84,420 KCAL/HR
ICS Steam Output	345 LB/HR 157 KG/HR

Approximate Fuel Consumption at Rated Capacity

	Natural Gas 1000 BTU/FT^3 8900 KCAL/M^3	LP Gas 2530 BTU/FT^3 22,500 KCAL/M^3	No. 2 Oil 140,000 BTU/GAL 9320 KCAL/LITRE
Input	420 FT^3/HR. 11.9 M^3/HR	170 FT^3/HR. 4.8 M^3/HR.	3 GPH 11.4 L/HR.
Pressure Required/Main Inlet	7"-11" W.C. 178-279 MM W.C.	14" W.C. 356 MM W.C.	N/A
Pressure Required/Last Elbow	3.5" W.C. & Back Pressure 89 MM W.C.	11" W.C. 279 MM W.C.	N/A
Pressure Required/Oil Pump	N/A	N/A	230 PSI 16.2 BARS

Electric Power Required (Amps)

Burner Motors	Gas	Oil
120V, 60 CY, 1 Phase	5.2	5.2
240V, 50/60 CY, 1 Phase	2.6	2.6
Control Circuit Only	4.0	4.0

Burner Motor Size	Gas	Oil
HP	1/3	1/3
Watts	248	248

Fuel Connection Sizes	IN NPT	MM
Gas Inlet	1	25
Oil Inlet	1/4	6

Recommended Draft Water Column Negative	IN	MM
Boiler Cold	.02 -.04	.51-1.02

Fresh air openings	FT^2	M^2
(2) per boiler room	1	.09

Boiler Connection Sizes	IN NPT	MM
Steam Outlet 15 PSI	1-1/2	38
Steam Outlet 16-150 PSI	1	25
Feedwater Inlet	1	25
Blowdown Outlet	1	25
Water Column Blow-down	1	25
Flue Outlet	6	152
Surface Blowdown opening	1-1/4	31
Safety Valve 100-150 PSI inlet	3/4	19
Safety Valve 100-150 PSI outlet	1	25
Safety Valve 15 PSI inlet	3/4	19
Safety Valve 15 PSI outlet	3/4	19

Water Content Of Boiler	U.S. GAL	LTR
	24	91

Approximate Dry Weight	LB	KG
	2000	910

Fulton

MAINTENANCE PACKAGE
FOR GAS FIRED
STEAM BOILERS

Prepared for:

PAMI
Highway #5 West
Humboldt, Saskatchewan
S0K 2A0

ICS-10 Boiler **S/N 97564**

CHECKLIST REPORT
FULTON BOILER WORKS CANADA INC.

DATE ____________

NATIONAL BOARD NO. 97564 MODEL ICS-10 FUEL Natural Gas

INSTALLATIONADDRESS: PAMI, Highway #5 West, Humboldt, Saskatchewan, S0K 2A0

DEALER/CUSTOMER NAME: Cypress Sales Partnership, 2615 Wentz Avenue, Saskatoon, SK S7K 5J1

INSPECTION FINDINGS PRELIMINARY — INITIAL FINDING — FINAL SETTINGS

1. Average distance Flame Rod to Grounding (if applicable)................... ____________
2. Setting of Ignition Electrode (Spark Gap) .... ____________

2a. Is Flame Detector sighting ignition spark? ______ yes ______ no

3. Are refractories in one piece?.. ____________
4. Conditions of Stainless Steel Oil Ring (if applicable)................ ____________
5. List Flame Safeguard Control.. ____________
6. Pressuretrol (High Pressure/Operating Pressure) Settings.. ____________
7. Do burner motor and pump motor have separate electrical sources?.... ____________

7a. Burner motor electrical characteristics ______ volts ______ phase ______ cycle

7b. Pump motor electrical characteristics ______ volts ______ phase ______ cycle

7c. Is Feedwater Motor wired internally for correct voltage? ______ yes ______ no

8. Overload Settings on Burner Motor... ____________
9. Motor Rotation Checked (from fan end clockwise).................... ____________
10. Fan Motor Size ____________
11. Air Switch Elbow Position... ____________
12. Water Softener? ______ 12a. Chemical Treatment Used? ____________
13. Note Feedwater/Check valve size ______ type ______ swing ______ or spring ______

Design Press: ______ 13a. Two Check valves installed between pump and boiler? ____________

14. Clearance Area around and over Boiler .... ____________
15. Size of return tank (if not by Fulton) ____________
16. City H_2O Pressure to Float Assembly.. ____________
17. Return Tank Temperature (not above 190° F)......................... ____________
18. Water Pump Model Number and H/P... ____________
19. GPH of Oil Nozzle (if applicable) ______ Mfg. ____________

Spray Angle ______ Cleanliness ______ Set to Specs? ______

Oil Tank Location ____________

20. Two Pipe System w/non-pressurized supply? (if applicable) ____________
21. Correct Oil Filter Used (Type) (if applicable)............................ ____________
22. Stack Height (including all runs) ______ Height above roof ______ How many elbows? ______

22a. Type of Vent ____________ (NOTE: B Vent NOT acceptable)

23. Barometric Damper Installed? ______ Type ______ Size ______
24. Type of Cap (Chinese or other) and location above termination ____________
25. Size of Stack ______ Condition and Run (Provide sketch if not to spec.) ____________
26. Draft OFF and cold.. ____________
27. Draft ON and Hot.. ____________

DATE______________________

Start-up by: (Company)______________________

(Person)______________________

(Copy of Fitters License) ______________________

COMMENTS/DEFICIENCIES:

CHOOSING THE RIGHT SIZE BAROMETRIC DRAFT CONTROL

Simple rules of thumb to guide size selections:

1. Use a draft control the same size as the flue pipe, that is, a 6" control for a 6" round pipe, a 12" control for a 12" pipe, etc.
2. For intermediate sizes of smoke pipe, use the next larger size draft control to provide ample capacity. It is a simple matter to install a round control on a pipe an inch or so larger or smaller than the control.
3. If the flue pipe or breeching is square, use the round equivalent. For example – on a 14" x 14" breeching, use a 14" control. Little flow occurs in the corners of a square pipe so that its capacity is approximately the same as a round pipe of the same diameter.
4. If the breeching is rectangular or oval, compute its cross-sectional area and select a draft control having the same or a greater nominal cross-sectional area. A breeching 14" high x 10" wide would have a cross-sectional area of 140 square inches. From the table, select a 14" control with a cross-sectional area of 154 sq. inches.
5. Where a control larger than 32" is required, use more than one regulator with combined cross-sectional areas equal to or greater than that of the breeching.

Control Size	Nominal Cross-Sectional Area (Sq. Inches)
6"	28
7"	38
8"	50
9"	63
10"	78
12"	113
14"	154
16"	201
18"	255
20"	314
24"	452
28"	616
32"	804

When chimneys are of an unusual height, or if the draft to be maintained is either very high or very low, it is advisable to deviate from the rules of thumb outlined here. Refer to the table below.

Diameter of Flue or Breeching	If Chimney Height Is	Use This Size Control	If Chimney Height Is	Use This Size Control	If Chimney Height Is	Use This Size Control
5	15' or less	6"	16' or more	6"		
6	15' or less	6"	16' or more	7"		
7	15' or less	7"	16' or more	8"		
8	15' or less	8"	16' or more	9"		
9	15' or less	9"	16' – 30'	10"	31' or more	12"
10	20' or less	10"	21' – 40'	12"	41' or more	14"
11	20' or less	12"	21' – 40'	12"	41' or more	14"
12	20' or less	12"	21' – 40'	14"	41' or more	16"
13	22' or less	14"	23' – 45'	16"	46' or more	18"
14	22' or less	14"	23' – 45'	16"	46' or more	18"
15	22' or less	16"	23' – 45'	16"	46' or more	18"
16	30' or less	16"	31' – 50'	18"	51' or more	20"
17	30' or less	18"	31' – 50'	20"	51' or more	20"
18	30' or less	18"	31' – 50'	20"	51' or more	20"
19	30' or less	20"	31' – 50'	20"	51' or more	24"
20	30' or less	20"	31' – 50'	20"	51' or more	24"
21	30' or less	20"	31' – 50'	24"	51' or more	24"
22	30' or less	24"	31' – 50'	24"	51' or more	24"
23	35' or less	24"	36' – 60'	24"	61' or more	28"
24	35' or less	24"	36' – 60'	24"	61' or more	28"
25	35' or less	24"	36' – 60'	28"	61' or more	28"
26	40' or less	28"	41' – 70'	28"	71' or more	28"
27	40' or less	28"	41' – 70'	28"	71' – 100'	28"
28	50' or less	28"	51' – 100'	28"	100' or more	32"
29	50' or less	32"	51' – 100'	32"	100' or more	32"
30	50' or less	32"	51' – 100'	32"	100' or more	32"
31	50' or less	32"	51' – 100'	32"	100' or more	TWO 24"
32	50' or less	32"	51' – 100'	32"	100' or more	ONE 24" ONE 28"
33	50' or less	32"	51' – 100'	ONE 32" ONE 20"	100' or more	ONE 32" ONE 24"
34	50' or less	32"	51' – 100'	ONE 32" ONE 24"	100' or more	ONE 32" ONE 24"

Glossary of Water Supply Corrosives and Inhibitors

Dissolved Oxygen:

Oxygen that is dissolved in the feedwater will cause the steel in the boiler and the feedwater system to be attacked by the water in a manner described as "pitting". The pits that are produced can vary from tiny depressions to holes large enough to penetrate the boiler metal and are usually covered with tubercles of iron oxide. Once pitting starts, it may be extremely hard to arrest. Pitting can proceed at a surprisingly rapid rate and can occur not only in the boiler proper, but also in pre-boiler equipment such as economizers, feedwater heaters, and feedwater lines.

Sodium Sulfite:

Purpose: To chemically remove the dissolved oxygen left in the feedwater after the feedwater has been mechanically deaerated.

Sodium Sulfite reacts chemically with dissolved oxygen, producing sodium sulfate. Since it is desirable to remove dissolved oxygen from the feedwater before it reaches a boiler, sodium sulfite is best introduced continuously at some suitable point in the feedwater system (the storage section of the feedwater heater or deaerator, six inches below the water line). Chemical residual control is based on the maintenance of a specific excess of sodium sulfite in the boiler water. The essential requirement being to maintain in the feedwater at all times slightly more than enough sodium sulfite to consume all of the dissolved oxygen that slips through the deaerating equipment. When sodium sulfite is not fed continuously, protection of the boiler against oxygen attack must depend on the reserve of sodium sulfite that is present in the boiler water. In this case, it is important that the feedwater and the boiler water are mixed thoroughly and as quickly as possible so that boiler water sodium sulfite may consume feedwater oxygen before the latter can cause damage to the boiler.

Sulfite as a treatment represents the second line of defense against oxygen corrosion. Primary protection against this type of attack requires adequate facilities for mechanical deaeration of the feedwater plus a vigorous maintenance program to safe guard against oxygen leakage into the pre-boiler system.

Suspended Solids:

Suspended solids are the undissolved matter in water, including dirt, silt vegetation, and any other insoluble organic matter. Normally suspended solids are expressed in terms of turbidity.

The presence of suspended solids in cooling water can increase impingement type corrosion. Suspended solids may also deposit in low velocity areas and create differential aeration cells. Pitting can result.

The most common cause of high suspended solids is high hardness feedwater. Of the agents which cause foaming, suspended solids probably have the least effect. Reasons for the increased hardness or other suspended solids should be determined.

In line filters or various types of pre-treatment can be used to lower the suspended solids level. Various polymers assist in holding solids in suspension.

Alkalinity:

Alkalinity is the capacity of a water to neutralize acids. Common water alkalinities consist of bicarbonate, carbonates, hydroxide, phosphate, and silicate. These alkalinities, especially bicarbonates and carbonates, break down to form carbon dioxide in steam, which is a major factor in the corrosion of condensate lines. High alkalinity also causes foaming and carryover in boilers.

Both foaming and carryover cause erratic boiler operation. When foaming occurs, an antifoam should be added or increased. Also the continuous blowdown rate should be increased. The reason for the high alkalinity should be determined. It may result from lack of sufficient blow down, pretreated makeup water and condensate should also be checked. Quite often the source of alkalinity is an overdose of alkaline internal water treatment chemical.

pH:

pH is a measure of the degree of acid or base of solution. Normal pH ranges from 6.5-9.0 will have little influence on the corrosion rate of cooling waters. If for some reason - pollution, etc. - the pH is lowered into the acid range, increased corrosion can be expected. The solution lies in determining the cause of the low pH and correcting that condition. A low pH can result in corrosion of metals, while a high pH can result in scale formation.

In order to control boilers and equipment used for the external treatment of make up water, it is essential that reliable pH measurements be made.

MANUFACTURER'S
ANNUAL INSPECTION OF
FULTON FUEL-FIRED
VERTICAL TUBELESS STEAM BOILERS

1. Open handholes and inspect for scale and sludge deposits.
2. Remove burner, inspect and clean. Check settings of ignition electrode and flame rod/mini peeper. Check condition of refractory rings. Check for sooting in primary pass of combustion chamber.
3. Check and clean water level and low probes.
4. Check operation of feedwater unit, clean pump strainer, and check valve(s).
5. Remove pipe plug at the cross tee below the water column and check for scale.
6. Replace water gauge glass and grommets.
7. Remove air gate and inspect/clean burner fan.
8. Check all operating and safety controls, including low water cut-off.
9. Note any 7800 programmer fault code histories, if applicable.
10. Check and set up combustion. Record all combustion readings on service report.
11. Advise in writing any recommendations or additional work required.

MAINTENANCE

(Gas-Fired Boiler)

To ensure the reliable operation and the efficiency of the boiler, follow the regular maintenance instructions detailed below.

In addition to normal hand tools, the following tools/equipment are required for start-up and annual maintenance:

Draft Gauge
CO Tester (Gas Boilers)
CO2 Tester
Multimeter
Smoke Tester (Oil Boilers)
Manometer

Honeywell Test Meter Q136A-Testjack 117053 (used on all Flame Safeguard Controls except 7800 Series).
7800 Keyboard Display (7800 Series Flame Safeguards only).
Stack Thermometer (range from 200°F to 1000°F).

If any fault is found during these operations, contact your Fulton representative.

DAILY OPERATION

1. Each morning start the boiler and generate not more than 10 psi of steam, then shut off the burner.

2. Open the boiler blow off valve for approximately 10 seconds, then close the valve.

3. Open the water column and the water gauge blow off valves for approximately 10 seconds, then close the valves.

   NOTE: If the boiler is being operated automatically on a time clock, the blow-down operation may be done at the end of the day.

4. If the feedwater is being treated by compounds, make sure that this treatment is carried out carefully and according to the specific manufacturer's instructions.

WEEKLY OPERATION

1. With the boiler under no more than 15 psi pressure, check that the steam safety valve is operating by lifting the lever.

2. Check that the low water cut-off relay is operating correctly in the following manner.

   (i) Make sure that the boiler is cool with little or no pressure showing on the steam pressure gauge.

   (ii) With the burner operating, open the boiler blowdown valve. When the water drops below the required level, (note the level in the water gauge glass), the burner should shut off; this is when the water level falls below the low water electrode in the water column assembly and/or the boiler shell.

the feedwater pump and the low water cut-off relay, as described in Section II.

7. Remove the air gate and clean fan.

NOTE: AFTER A NEW FULTON BOILER HAS BEEN IN OPERATION FOR SEVERAL MONTHS, PIECES OF BURNED METAL WILL BE FOUND IN THE SPACE AT THE BOTTOM OF THE BOILER. THESE PIECES OF METAL ARE THE REMAINS OF A LIGHT

GAUGE METAL FORM WHICH WAS USED DURING MANUFACTURE FOR FORMING THE BOILER INSULATION. THIS IS A NORMAL CONDITION AND DOES NOT AFFECT THE EFFICIENCY OR THE LIFE OF THE BOILER IN ANY WAY.

Serial Number: ______________________

Model Number: ______________________

Fulton Order Number: ______________________

Sold To: ______________________

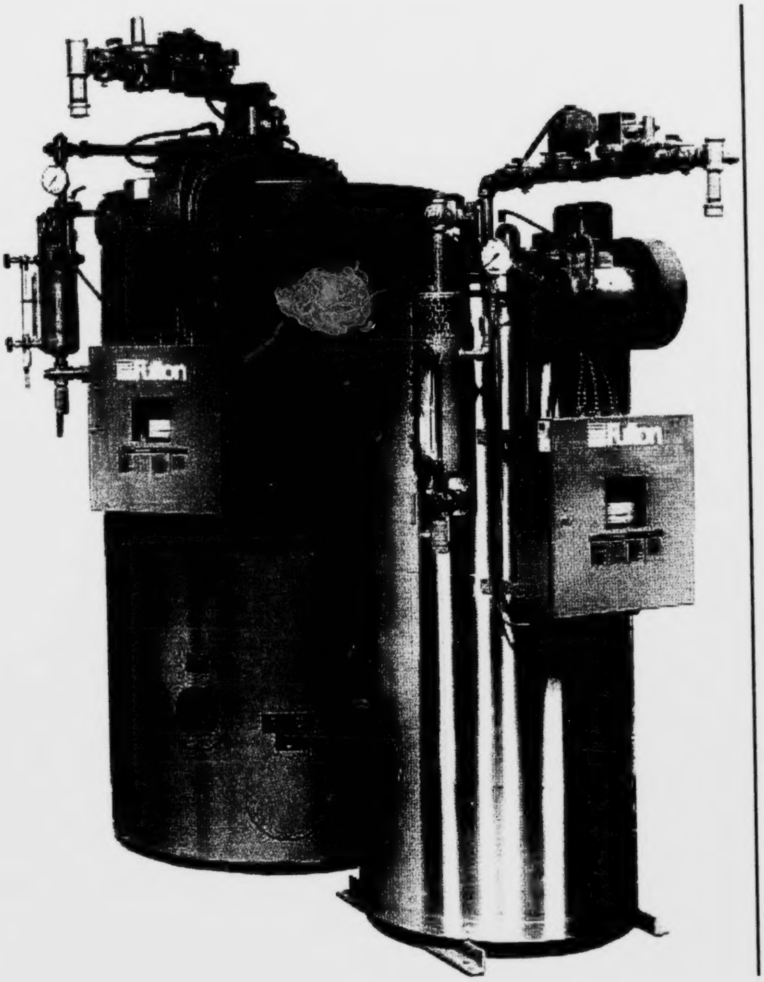
Job Name: ______________________

Date: ______________________

Instruction, Operation, and Maintenance Manual

Fulton Gas Fired Steam Boilers

4 HP to 60 HP



Introduction

This manual is provided as a guide to the correct operation and maintenance of your Fulton Gas Fired Steam Boiler, and should be permanently available to the staff responsible for the operation of the gas fired boiler.

These instructions must not be considered as a complete code of practice, nor should they replace existing codes or standards which may be applicable.

The requirements and instructions contained in this section generally relate to the standard Fulton Gas Fired Steam Boiler. When installing a packaged unit, this entire section should be read to ensure that the installation work is carried out correctly.

Prior to shipment the following tests are made to assure the customer the highest standards of manufacturing:

a) Material inspections.
b) Manufacturing process inspections.
c) ASME welding inspections.
d) ASME hydrostatic test inspection.
e) Electrical components inspection.
f) Operating test.
g) Final Engineering Inspection
h) Crating inspection.

NOTE

The installation of the Fulton Gas Fired Steam Boiler should be carried out by competent personnel in accordance with the standards of the National Fire Protection Association, National or Canadian Electrical Code. All state and jurisdictional codes beyond the scope of the applicable ASME Boiler and Pressure Vessel Codes, for its corresponding classification, should be followed in all cases. Jurisdictional authorities must be consulted prior to installation.

All units are crated for fork lift transport. Once uncrated, all units can be transported with a forklift. Under no circumstances should weight be allowed to bear on the jacket, control panel, or fan housing of any Fulton Boiler.

Rigging your boiler into position should be handled by a competent rigger experienced in handling heavy equipment.

The customer should examine the boiler for any damage, especially the refractories.

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1

Safety Warnings/Precautions

Safety Warnings Cautions & Notes

The following **WARNINGS**, **CAUTIONS,** and **NOTES** appear in various chapters of this manual. They are repeated on these safety summary pages as an example and for emphasis.

WARNINGS must be observed to prevent serious injury, or death to personnel.

CAUTIONS must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.

NOTES must be observed for essential and effective operating procedures, conditions, and as a statement to be highlighted.

It is the responsibility and duty of all personnel involved in the operation and maintenance of this equipment to fully understand the **WARNINGS**, **CAUTIONS**, and **NOTES** by which hazards are to be reduced or eliminated. Personnel must become thoroughly familiar with all aspects of safety and equipment prior to operation or maintenance of the equipment.

CAUTION

Some soaps used for leak testing are corrosive to certain types of metals. Rinse all piping thoroughly with clean water after leak check has been completed.

NOTE

Where a condensate return tank is to be fitted, this should:

1. Be vented and

2. Have a capacity sufficient to satisfy boiler consumption as well as maintain proper return tank temperature.

3. Vent pipe should not be downsized (This may cause pressure build up in the condensate tank.)

4. Return pipes must not be insulated. This can cause overheating the return system, causing a vapor lock in the pump.

5. See Return System Instruction Manual for detailed instructions.

NOTE

Care should be taken to ensure that the blow off receptacle used meets the regulations covering such vessels. If in doubt consult a Fulton Representative for advice.

NOTE

Only properly trained personnel should install and maintain water gauge glass and connections. Wear safety glasses during installation. Before installing, make sure all parts are free of chips and debris.

NOTE

Keep gauge glass in original packaging until ready to install.

WARNING

Improper installation or maintenance of gauge glass and connections can cause immediate or delayed breakage resulting in bodily injury and/or property damage.

NOTE

After installation is complete and prior to operation the pressure vessel should be cleaned.

CAUTION

Do not store halogenated hydrocarbons near or in the boiler room.

NOTE

a) The fused disconnect switch that controls the feed water pump should be kept in the "on" position at all times during the boiler operation as well as during the non-operating period of the boiler.

b) This switch should be turned "off" only when repairs or adjustments should be made.

NOTE

The pump will continue to operate until the water reaches the correct level in the boiler. This level is approximately the center of the water gauge glass.

WARNING

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be disconnected.

CAUTION

Do not tamper with the safety features of the low water safety cut off.

WARNING

When stopping the boiler for any extensive repairs, shut off main disconnect switches on both the boiler side as well as the feed water side.

NOTE

To ensure that your Fulton Steam Boiler is kept operating safely and efficiently, follow the maintenance procedures set forth in Section 4 of this manual.

NOTE

To ensure the continued safety and efficiency of the boiler, the schedule of maintenance outlined in this section should be adhered to.

WARNING

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be disconnected.

NOTE

The scanner is located on the outside edge of the burner top plate for 20-60 HP.

NOTE

If only the top refractory is to be changed, the bottom refractory need not be broken.

NOTE

If the boiler is being operated automatically on a time clock, the blow off operation may be done once during the working day and once at the end of the day when at 10 PSIG or less.

NOTE

Fulton recommends that the feedwater treatment should be added between the pump and the boiler.

WARNING

Make sure main power switch is off before starting work.

CAUTION

Do not clean the gauge or glass while pressurized or in operation.

NOTE

After a new Fulton Boiler has been in operation for several months, pieces of burned metal will be found in the space at the bottom of the boiler. These pieces of metal are the remains of a light gauge metal form which was used during manufacture for forming the boiler insulation. This is a normal condition and does not affect the efficiency or the life of the boiler in any way.

LE

LE Specifications

Standard Models FBA & ICS		**9.5**	**10**	**15**	**20**	**30**
Models FBF & ICX			**10**	**15**	**20**	**30**
Unit Size:	BHP	9.5	10	15	20	30
Ratings ** (Sea Level to 3000 ft.)						
Output FBA & ICS	1000 BTU/HR	318	335	502	670	1004
	1000 KCAL/HR	80	84	137	169	253
Output FBF & ICX	1000 BTU/HR	N/A	345	517	690	1035
	1000 KCAL/HR		87	130	173	260
Steam Output FBA & ICS	LB/HR	328	345	518	690	1035
	KG/HR	149	157	235	312	470
Steam Output FBF & ICX	LB/HR	N/A	356	533	712	1066
	KG/HR		162	242	323	484
Approximate Fuel Consumption at Rated Capacity +						
Natural Gas	FT^3/HR	398	420	630	840	1260
	M^3/HR	11.3	11.9	17.8	23.8	35.7
Natural Gas Boiler Connection Size	IN	1	1	1	1.25	1.5
	MM	25	25	25	32	38
Gas Pressure Required	inches w.c.	7-11	7-11	7-11	7-11	7-11
Burner Motor HP	3450 RPM/60 CY	3/4	3/4	3/4	1.5	2
Electric Power Requirements (in Amps)						
120V, 60 CY, 1 Phase		9.2	9.2	9.2	-	-
240V, 50/60 CY, 1 Phase		4.6	4.6	4.6	8.9	12
208V, 50/60 CY, 3 Phase		3.1	3.1	3.1	4.4	7.5
240V, 50/60 CY, 3 Phase		2.8	2.8	2.8	4.2	6.8
480V, 50/60 CY, 3 Phase		1.4	1.4	1.4	2.6	3.4

** All ratings from 0 PSIG and at 212 degrees F.

+ Consumption based on Natural Gas 1000 BTU/ft^3

-- Consult factory.

LE Dimensions and Weights

Unit Size	BHP	9.5	10	15	20	30
Heights and Widths						
A. Boiler Height	IN	67.5	63.5	69.5	72.5	82.5
	MM	1715	1613	1765	1842	2096
B. Boiler Heights with Trim & Fuel Train Assembly	IN	87	83	89	94	103
	MM	2210	2109	2261	2388	2617
C. Overall Depth Stack to Burner Fan Housing	IN	44	46	47	59	66
	MM	1118	1169	1194	1499	1677
D. Boiler Diameter	IN	28	28	30	39	46
	MM	711	711	760	990	1170
E. Overall Width with Water Column	IN	33.5	33.5	35.5	43	49
	MM	8851	851	902	1091	1244
F. Flue Outlet Diameter	IN	6	6	8	10	12
	MM	152	152	203	254	305
G. To Center of Flue Outlet	IN	61.5	58	63	66	73.5
	MM	1562	1473	1600	1675	1867
Minimum Clearances						
H. Clearance Required for Trim & Burner Removal	IN	92	89	101	104	114
	MM	2337	2261	2616	2642	2896
I. Opening Required for Boiler Installation with Water Column Removed	IN	28	28	30	39	46
	MM	710	710	760	990	1170
J. Front of Boiler	IN	41	41	41	41	41
	MM	1041	1041	1041	1041	1041
K. Sides & Rear of Boiler **	IN	36	36	36	36	36
	MM	914	914	914	914	914
Water Content	U.S. Gal	16	24	39	77	170
	LITERS	61	91	148	292	644
Weight						
Approx. Shipping Weight	LB	1900	2000	2280	3400	4780
	KG	862	910	1036	1545	2173

** Clearances for boilers below 50 PSIG are 18" on sides and rear of boiler.

Locating the Boiler

a. See page 8-G

b. See page 8-G

c. It is necessary to have the following vertical clearance from the floor to the ceiling for removal of the burner for servicing:

Minimum Vertical Clearances

BHP	IN	MM
9.5	92	2337
10	89	2261
15	101	2616
20	104	2642
30	114	2896

The Gas Supply

See page 8-G

See pages 9-G through 19-G for remander of Description and Instructions

LE

Starting the Gas Fired Boiler

See page 44-G

Gas Burner Set Up

a. Open the manual gas cocks on the pilot and main lines of the gas head.

b. Switch on the main power to the burner. The water level relay is equipped with a manual reset. Depress the button on the box.

c. The flame programmer is the main control in the panel box. The programmer in conjunction with a UV scanner "supervises" the ignition sequence - proves the flame is satisfactory, and finally "monitors" the established flame. Should any fault occur, either during the ignition sequence or during normal running, the programmer will immediately go to "lock-out" and the burner will shut down.

d. When the pilot flame is established, the ultra-violet scanner senses the flame. This signal is transmitted back to the flame programmer which opens the main gas valve giving a main flame.

e. If the installation is new or the burner has been disassembled, the burner may not fire at the first attempt due to air which must be purged from the gas lines. This will result in the burner flame programmer going to lockout. Repeat the procedure for starting the burner.

f. The main gas valve will remain open as long as there is a demand for heat and the flame is carrying a sufficient signal to the flame programmer.

g. If the flame is not established at the start, the safety switch in the flame programmer control will open the contacts and shut off the burner.

h. Push the reset button on the control to reset. If trouble persists, it may be necessary to check the UV scanner. See Maintenance Section for procedure to check UV Scanner.

Air adjustment for Fulton LE Gas Fired Steam Boilers.

a. The primary air adjustment or main air control is located at the fan housing inlet. This control is used to supply the burner with air needed to facilitate good combustion. Too much or too little air will result in poor combustion. Using a CO_2 or O_2 tester, it is possible to determine the percent of excess air in the combustion mixture. Refer to Factory Test Fire Report for acceptable ranges.

LE

Pilot Adjustment for Fulton LoNOx Burner.

a. Close downstream main shut off valve.

b. Start boiler and check flame signal on pilot, lock programmer into pilot hold.

c. Adjust gas regulator as needed to obtain a strong pilot signal.

d. Slowly open downstream shut off valve and take the flame programmer off of hold.

Main Flame Adjustment

a. Place a combustion analyzer in the exhaust of the boiler.

b. Adjust main gas regulator until last elbow pressure matches the test fire sheet.

NOTE: Adjust air accordingly to ensure stable combustion during gas adjustments.

c. Adjust air setting until combustion readings are within specifications and stable combustion is present. Refer to Fulton test fire report for acceptable ranges.

Burner Tile Replacement

a. Remove scroll assembly.

b. Break off top holding clips.

c. Remove ceramic fiber burner tile.

d. Replace burner tile bottom holding clips if needed.

e. Replace with new burner tile.

f. Carefully replace scroll assembly so that the ceramic fiber burner tile is not damaged.

Troubleshooting

a. The following troubleshooting guide will assist in the diagnosis and the correction of minor field problems. It contains instruction and information necessary to locate and isolate possible troubles which occur during normal operation. It should be used in conjunction with the unit wiring diagram and the component literature provided in Section 7 of this manual.

b. The following lists cover the most common troubles that may occur on the Fulton gas fired boilers. Refer to left hand column of the chart to locate the problem. Determine which cause, listed in the center column, that represents the problem by performing the corrective action as listed in the right hand column titled "REMEDY".

Troubleshooting Gas-Fired Boilers

Problem	Cause	Remedy
Ignition Failure	1. Power Supply	Check fuse or circuit breaker. Reset or replace, as necessary.
	2. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustments. Readjust if necessary. Check for cracks in porcelain. If found, replace.
	3. Transformer	Check voltage between transformer leads at terminal block to be sure transformer is being powered.
	4. Flame Safeguard Control	Check voltage between ignition terminal and neutral. Check must be made before control locks out on safety. If no power, replace control.
	5. Faulty Air Switch	Check for bad air switch by jumpering the two air switch leads at the terminal block. If the boiler starts and runs with these terminals jumpered, the air switch should be replaced.
	6. Gas Valve Sticking (Pilot)	Check for dirt in valve or orifice and clean if necessary. Check for faulty actuator or valve and replace if necessary.
	7. Gas Supply	Check for gas pressure and for intermittent supply problems. See test fire sheet for last elbow.
	8. Loose wire connection	Check connections to all components.
Flame Failure	1. Power Supply	Check fuse or circuit breaker. Reset or replace, as necessary.
	2. Gas Supply	Check for gas pressure and for intermittent supply problems.
	3. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustment. Readjust if necessary. Check for cracks in porcelain; if found, replace.
	4. Primary Air Adjustment	Check air adjustment. Air may be blowing flame away from burner head.

LE Maintenance

Problem	Cause	Remedy
Flame Failure	5. Scanner	Check for dirt on flame scanner and clean. Check for proper location of detector.
	6. Flame Safeguard Control	Check voltage at terminal leading to main gas valve. If no power, replace the control.
	7. Loose wire at fuel valve circuit	Tighten wiring connections.
	8. Contact open on air safety switch	Adjust to proper setting.
	9. Scanner wiring reversed at panel box	Change to correct terminals.
Burner Cut-Off	1. Power Supply	Check fuse or circuit; reset or replace, as necessary.
	2. Gas Supply	Check to be sure main gas cock is not closed. Check coil in gas valve with OHM meter. Replace if faulty. Check gas regulator setting and readjust as necessary. Check inlet gas pressure and increase or decrease as necessary.
	3. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary.Check for proper adjustment. Readjust if necessary. Check for cracks in porcelain; if found, replace.
	4. Scanner	Check for dirt on flame scanner and clean. Check for proper location of detector.
	5. Air Switch	Check for bad air switch by jumpering the two air switch leads as the terminal block. If the boiler starts and runs with these terminals jumpered, the air switch should be replaced.
	6. Gas Valve Sticking (Pilot)	Check for dirt in valve or orifice and clean if necessary. Check for faulty actuator or valve and replace if necessary.
	7. Weak Amplifier	Replace.
	8. Weak Pilot	Adjust to larger pilot by adjusting pilot gas pressure regulator.
	9. Faulty Liquid Level Control	Check to see if there is power to terminal number 10 when the sight glass shows the proper water level. If there is no power at this terminal, the control is bad and must be replaced.
	10. Dirty or defective UV Scanner	Clean or replace.

LE Maintenance

Problem	Cause	Remedy
Poor Combustion	1. Refractories	Check refractories to see if they are plugged with soot or broken in pieces. Clean or replace as necessary.
	2. Air Adjustment	Check main air adjustment to see if it is loosened up. Adjust as necessary and tighten plate in position. Check CO_2 and O_2 levels.
	3. Draft	Check draft with a gauge. Draft should be a -.02" to -.04" W.C. with burner off or -.04" to -.06" when operating. May need to install a barometric damper.
	4. Dirty Flue	Check flue for carbon buildup or blockage. Clean flue passages with brush.
	5. Negative Room Pressure	Make sure no exhaust fans are running in the boiler room.
Burner back fires	1. Refractories	Check refractories to see if they are plugged with soot or broken in pieces. Replace as necessary.
	2. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustment. Readjust if necessary. Check for cracks in porcelain; if found, replace.
	3. UV Scanner	Check for dirt on flame scanner and clean. Check for proper location of detector.
	4. Draft	Check draft with a gauge. Draft should be a -.02" to -.04" W.C. with burner off or -.04" to -.06" when operating. May need to install a barometric damper.
	5. Negative Room Pressure	Make sure no exhaust fans are running in the boiler room.
Boiler will not maintain pressure	1. Gas Supply	Check gas pressure coming into gas train. If low, contact gas company. Should be 7" to 11" W.C. Check coil in gas valve with AMP meter. Replace if bad. Check gas regulator setting and readjust as necessary.
	2. Dirty Flue	Check flue for carbon buildup or blockage. Clean flue passages with brush.
	3. Pressuretrol	Disconnect all power to the controller. Disconnect the wires from the controller. Put an OHM meter between the switch terminals. Lower the set point and recheck with OHM meter. Switch should break. If the controller operates improperly, replace it.
	4. Scale Built up in boiler	Refer to Section 2 "Pressure Vessel Cleaning".
	5. Refractories	Check refractories to see if they are cracked or broken in pieces. Replace as necessary.
	6. Steam traps blowing through	Check traps to see if they are clean or replace as necessary.
	7. Boiler size	Boiler may be undersized.

LE Maintenance

Problem	Cause	Remedy
Boiler is Surging	1. Steam traps blowing through	Check traps to see if they are clean or replace as necessary.
	2. Perc (cleaning solvent in boiler)	Clean boiler with washing soda per instruction manual.
	3. Scale build-up or lime deposits	Call water treatment professional and consult factory.
	4. Too much compound in system (water treatment)	Dump return tank and flush system. Have water tested by water treatment company.
	5. Too much water softener (high PH)	Have water tested by water treatment company.
	6. Too much of a load	Check total equipment horsepower required against horsepower of boiler being used. Decrease amount of equipment being used at one time.
	7. Boiler new (not cleaned)	Clean per instructions in instruction manual.
Boiler Rumbles and Pulsates	1. Draft problem	Check draft with a gauge. Draft should be a -.02" to -.04" W.C. with burner off or -.04" to -.06" when operating. May need to install a barometric damper.
Boiler pushing water with the steam	1. Steam Traps	Chech traps. Clean or replace as necessary.
	2. Too much boiler compound	Dump return tank and flush system. Have water tested by water treatment company.
Pump will not cut off	1. Dirty Probes	Clean or replace as necessary.
	2. Relay failed	Make sure relay is plugged in tightly. If so, replace water level relay.
	3. Ground Connection	Check for tightness and clean.
Pump runs but does not put water into boiler	1. Vapor locking of pump	Allow system to cool down, check steam traps and check to be sure return lines are not insulated. Check return tank temp. If it is above 180°F., (82°C.) vapor locking of pump will occur. Inspect check valves. Clean and replace as needed. Replace pump with multistage centrifugal good for 250°F. (121°C.).
	2. Impeller Adjustment	Check for impeller wear and adjust per component information in instruction manual (Burks only).
	3. Back pressure on pump	Need to install repair kit on pump.
	4. Plugged feed water nipple	Check and clean or replace as necessary.

LE Maintenance

Problem	Cause	Remedy
Water pump will not come on at times	1. Scale on probes	Check and clean or replace as necessary.
	2. Bad Pump Contactor	Check to see if contactor is being powered. Check to see if contactor coil is pulling in. Replace if necessary.
	3. Bad Pump Motor	Check the incoming power to the pump to be sure it is receiving power. If power is present but motor does not run, replace it.
Low Fuel pressure	1. Gas pressure regulator	Check and replace.
Boiler Flooding	1. Pump does not shut off	Dirty probes. Clean or replace as necessary.
	2. Relay failed	Make sure relay is plugged in tightly. If so, replace water level relay.
	3. Ground Connection	Check for tightness and clean.
	4. Vacuum created with boiler off	As the boiler cools off, it pulls water from the system piping. To prevent this, add a 1/4" check valve on the steam gauge assembly piping, which closes under pressure and opens under vacuum. .

LE

LE Parts

Spare Parts

a. It is important that the correct replacement part is fitted to your Fulton Gas Fired Steam Boiler.

b. When ordering replacement or spare parts, make sure that the full information given in the Parts List is supplied, together with the following details as shown on your boiler identification plate:

1. Boiler Number
2. Boiler Type
3. Electrical Specifications

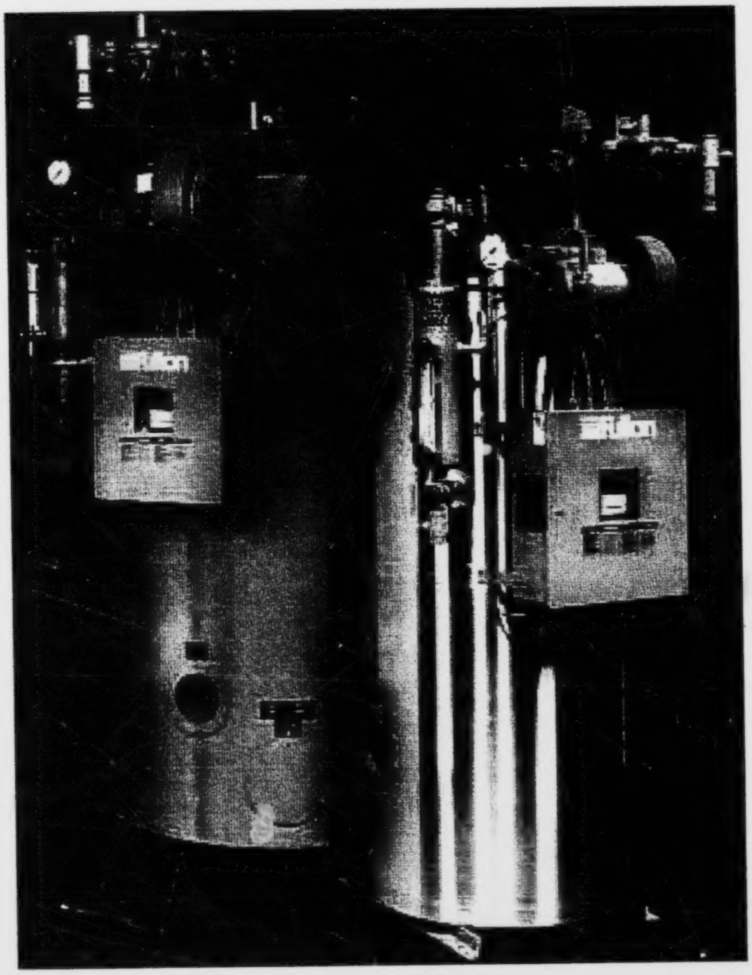
NOTE:

The policy of Fulton Boiler Works, Inc. is one of continuous improvement, and therefore, we reserve the right to change prices, specifications, and equipment without notice.

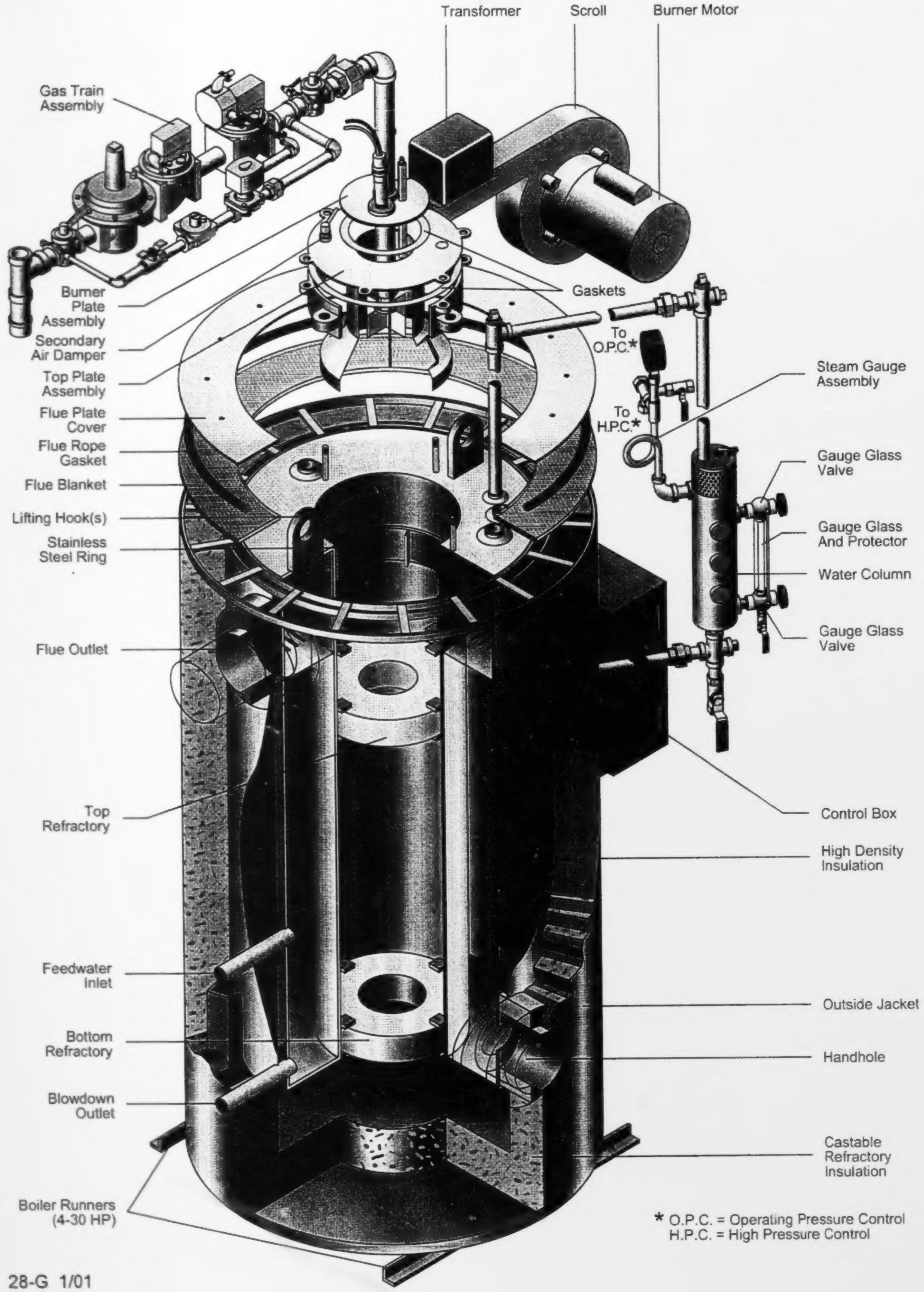
Replacement Parts Listing (available from authorized Fulton Representative)

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-12-219	Furnace Burner Tile (9.5 HP)	2	.91
2-12-253	Furnace Burner Tile (10 HP)	2	.91
2-12-221	Furnace Burner Tile (15 HP)	2	.91
2-12-254	Furnace Burner Tile (20-30 HP)	15	6.8
5-21-6009	Burner Scroll (9.5 HP)	30	13.6
5-21-6010	Burner Scroll (10 HP)	45	20.4
5-21-6015	Burner Scroll (15 HP)	55	24.9
5-21-6030	Burner Scroll (20 HP)	65	29.5
5-21-6031	Burner Scroll (30 HP)	65	29.5
2-30-1330	Blower Assembly (9.5 - 10 HP)	22	9.98
2-30-1331	Blower Assembly (15 - 20 HP)	30	13.6
2-30-1339	Blower Assembly (30 HP)	35	15.9
2-20-18	Ignition Electrode (9.5 - 10 HP)	.5	.23
2-20-30	Ignition Electrode (15, 20, 30 HP)	.4	.18
5-10-610	Burner Assembly LoNOx (9.5 - 10 HP)	35	15.9
7-30-571	Burner Assembly LoNOx (15 HP)	45	20.4
7-30-672	Burner Assembly LoNOx (20 HP)	55	24.9
7-30-673	Burner Assembly LoNOx (30 HP)	55	24.9
2-30-819	O ring for Pilot Tube LoNOx - 1.76 ID x .070)	.01	.005
2-30-813	O ring for Pilot Tube LoNOx - 8.7 mm x 1.78 mm)	.01	.005
2-40-631	Temperature Limit LoNOx	3	1.37
2-40-803	Thermocouple High Limit LoNOx	.2	.09

2


Fulton
Fulton

Description/Instructions


Transformer
Scroll
Burner Motor
Gas Train Assembly
Burner Plate Assembly
Secondary Air Damper
Top Plate Assembly
Flue Plate Cover
Flue Rope Gasket
Flue Blanket
Lifting Hook(s)
Stainless Steel Ring
Flue Outlet
Top Refractory
Feedwater Inlet
Bottom Refractory
Blowdown Outlet
Boiler Runners (4-30 HP)
Gaskets
To O.P.C.*
To H.P.C.*
Steam Gauge Assembly
Gauge Glass Valve
Gauge Glass And Protector
Water Column
Gauge Glass Valve
Control Box
High Density Insulation
Outside Jacket
Handhole
Castable Refractory Insulation

* O.P.C. = Operating Pressure Control
H.P.C. = High Pressure Control

Description/Instructions

Specifications*

Standard Models FBA & ICS		4	6	9.5	10	15	20	30	40	50	60
Models FBF & ICX					10	15	20	30			
Unit Size:	BHP	4	6	9.5	10	15	20	30	40	50	60
Ratings (Sea level to 3000 ft.)**											
Output FBA & ICS	1000 BTU/HR	134	201	318	335	502	670	1004	1340	1674	2009
	1000 KCAL/HR	34	51	80	84	127	169	253	338	422	506
Output FBF & ICX	1000 BTU/HR				345	517	690	1035			
	1000/KCAL/HR				87	130	173	260			
Steam Output FBA & ICS	LB/HR	138	207	328	345	518	690	1035	1380	1725	2070
	KG/HR	63	94	149	157	235	312	470	627	783	939
Steam Output FBF & ICX	LB/HR				356	533	712	1066			
	KG/HR				162	242	323	484			
Approximate Fuel Consumption at Rated Capacity+											
Propane Gas	FT^3/HR	70	105	157	170	250	330	500	665	830	1000
	M^3/HR	2	3	4.4	4.8	7.1	9.3	13.6	18.1	23.5	28.3
Natural Gas	FT^3/HR	175	260	398	420	630	840	1260	1675	2100	2520
	M^3/HR	5	7.4	11.3	11.9	17.8	23.8	35.7	47.4	59.5	71.4
Natural Gas Boiler	IN	1	1	1	1	1	1.25	1.5	1.5	1.5***	2
Connection Size	MM	25	25	25	25	25	32	38	38	38	50
Burner	3450 RPM/60 CY										
Motor HP	2850 RPM/50 CY	1/3	1/3	1/3	1/3	1/3	1/3	3/4	1.5	1.5	1.5
Electric Power Requirements (in Amps)											
120V,60 CY, 1 Phase		5.2	5.2	5.2	5.2	5.2	5.2	9.2	--	--	--
240V, 50/60 CY, 1 Phase		2.6	2.6	2.6	2.6	2.6	2.6	4.6	8.9	8.9	8.9
208V, 50/60 CY, 3 Phase		1.9	1.9	1.9	1.9	1.9	1.9	3.1	4.4	4.4	4.4
240V, 50/60 CY, 3 Phase		1.6	1.6	1.6	1.6	1.6	1.6	2.8	4.2	4.2	4.2
480V, 50/60 CY, 3 Phase		.8	.8	.8	.8	.8	.8	1.4	2.6	2.1	2.1

*Non Low Emission units

**All ratings from 0 PSIG and at 212 degrees F.

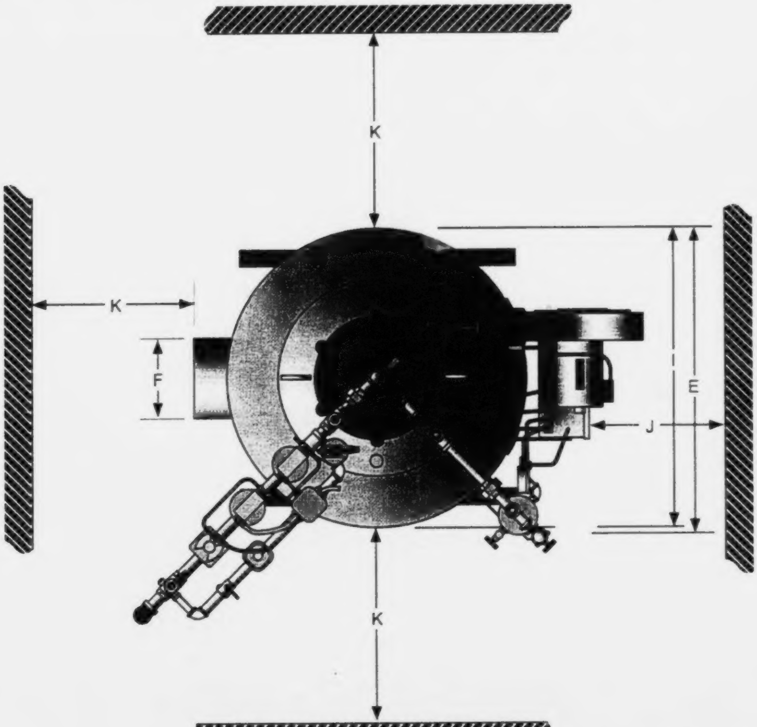
+ Consumption based on Natural Gas 1000 BTU/ft^3; Propane 2530 BTU/ft^3.

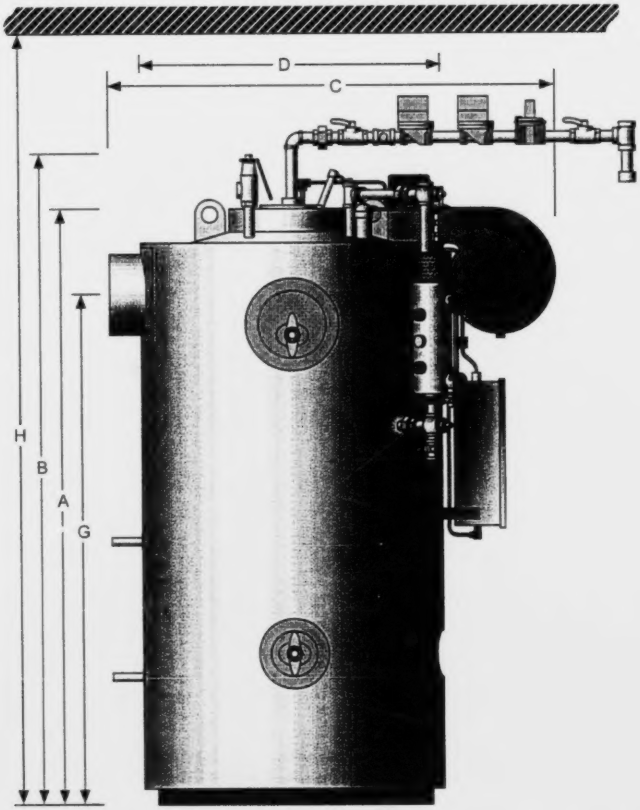
-- Consult factory.

***2"/50mm IRI and CSA

High pressure boilers ordered with an extra pressure control for night heating have less than rated output while operating at low pressure. Specifications and Dimensions are approximate. We reserve the right to change specifications and/or dimensions.

Description/Instructions





Description/Instructions

Dimensions and Weights

Unit Size	**BHP**	**4**	**6**	**9.5**	**10**	**15**	**20**	**30**	**40***	**50**	**60**
Heights and Widths											
A. Boiler Height	IN	47.5	57.5	67.5	63.5	69.5	72.5	82.5	73.5	87.5	93.5
	MM	1207	1461	1715	1613	1765	1842	2096	1867	2223	2375
B. Boiler Height With Trim & Fuel Train Assembly	IN	65	75	83	80.5	86.5	92.5	102	94	106.5	120
	MM	1651	1905	2108	2045	2197	2350	2591	2388	2705	3048
C. Overall Depth Stack to Burner Fan Housing	IN	44	44	40	46	47	60	67	73	78	78
	MM	1118	1118	1016	1168	1194	1524	1702	1854	1981	1981
D. Boiler Diameter	IN	26	26	28	28	30	39	46	55	55	55
	MM	660	660	711	711	760	990	1170	1397	1400	1400
E. Overall Width with Water Column	IN	33	33	33.5	33.5	35.5	43	49	57	57	57
	MM	838	838	8851	851	902	1091	1244	1448	1448	1448
F. Flue Outlet Diameter	IN	6	6	6	6	8	10	12	12	12	12
	MM	152	152	152	152	203	254	305	305	305	305
G.To Center of Flue Outlet	IN	42	52	61.5	58	63	66	73.5	62	79	85
	MM	1070	1320	1562	1473	1600	1675	1867	1575	2007	2159
Minimum Clearances											
H.Clearance Required for Trim & Burner Removal	IN	72	82	86	86	92	96	106	104	114	124
	MM	1828	2083	2184	2184	2337	2438	2692	2642	2896	3150
I. Opening Required for Boiler Installation with Water Column Removed	IN	26	26	28	28	30	39	46	55	55	55
	MM	660	660	710	710	760	990	1170	1397	1397	1397
J. Front of Boiler	IN	41	41	41	41	41	41	41	41	41	41
	MM	1041	1041	1041	1041	1041	1041	1041	1041	1041	1041
K.Sides & Rear of Boiler**	IN	36	36	36	36	36	36	36	36	36	36
	MM	914	914	914	914	914	914	914	914	914	914
Water Content	U.S. GAL	14	16	16	24	39	77	170	220	245	270
	LITERS	53	61	61	91	148	292	644	835	927	1022
Weight											
Approx. Shipping Weight	LB	1400	1700	1900	2000	2280	3400	4780	6400	6526	7280
	KG	635	773	862	910	1036	1545	2173	2909	2966	3309

*Available for Export Only.

**Clearances for boilers below 50 PSIG are 18" on sides and rear of boiler.

Locating the Boiler

a) The boiler should be located in dry surroundings on a level base, making sure that there is sufficient room around the boiler to enable the operator and/or the maintenance engineer to gain access to all parts of the boiler. Check location for ease of water supply and electrical connections.

b) Place the boiler on a non combustible floor with clearances to unprotected combustible materials, including plaster or combustible supports.

c) It is necessary to have the following vertical clearance from the floor to the ceiling for removal of the burner for servicing:

Minimum Vertical Clearances

BHP	IN	MM
4	72	1828
6	82	2083
9.5	86	2184
10	86	2184
15	92	2337
20	96	2438
30	106	2692
40	104	2642
50	114	2896
60	124	3150

The Gas Supply

a) Gas Piping should be installed in accordance with National Fuel Gas Code, ANSI-Z223-1-1984 or latest addenda and any other local codes which may apply. In Canada gas installations must be in accordance with the current CAN/CGA B149.1 and .2 and/or local codes.

b) Install a dirt trap ahead of all of the gas valves.

c) The pipe and the fittings used must be new and free of dirt or other deposits.

d) The piping must be of the proper size to ensure adequate gas supply to the gas head assembly. Consult your gas company for specific recommendations.

e) For natural gas a pressure of 7" to 11" (178mm to 279mm) of water column pressure at the gas train is required with burner firing. Do not exceed 13" of water column.

f) For propane or butane gas the pressure required is 11" (279 mm) of water column pressure. Again, do not exceed 13" of water column.

g) When making gas piping joints, use a sealing compound resistant to the action of liquefied petroleum gases. Do not use teflon tape on gas line threads.

h) The main and the pilot gas pressure regulators must be vented to the atmosphere.

i) After gas piping is completed carefully check all piping connections, (factory and field), for gas leaks. Use a soap and water solution.

CAUTION

Some soaps used for leak testing are corrosive to certain types of metals. Rinse all piping thoroughly with clean water after leak check has been completed.

j) The boiler must be disconnected at the boiler shut off valve from the gas supply piping system during any pressure testing of the system at pressure in excess of 1/2 PSIG–14" W.C.

k) The boiler must be isolated from the gas supply piping system by closing the shut-off cock during any pressure testing of the gas supply piping system at pressures equal to or less than 1/2 PSIG–14" W.C.

Basic Boiler, Condensate Tank, and Blow off Separator

NOTE

Where a condensate return tank is to be fitted, this should:

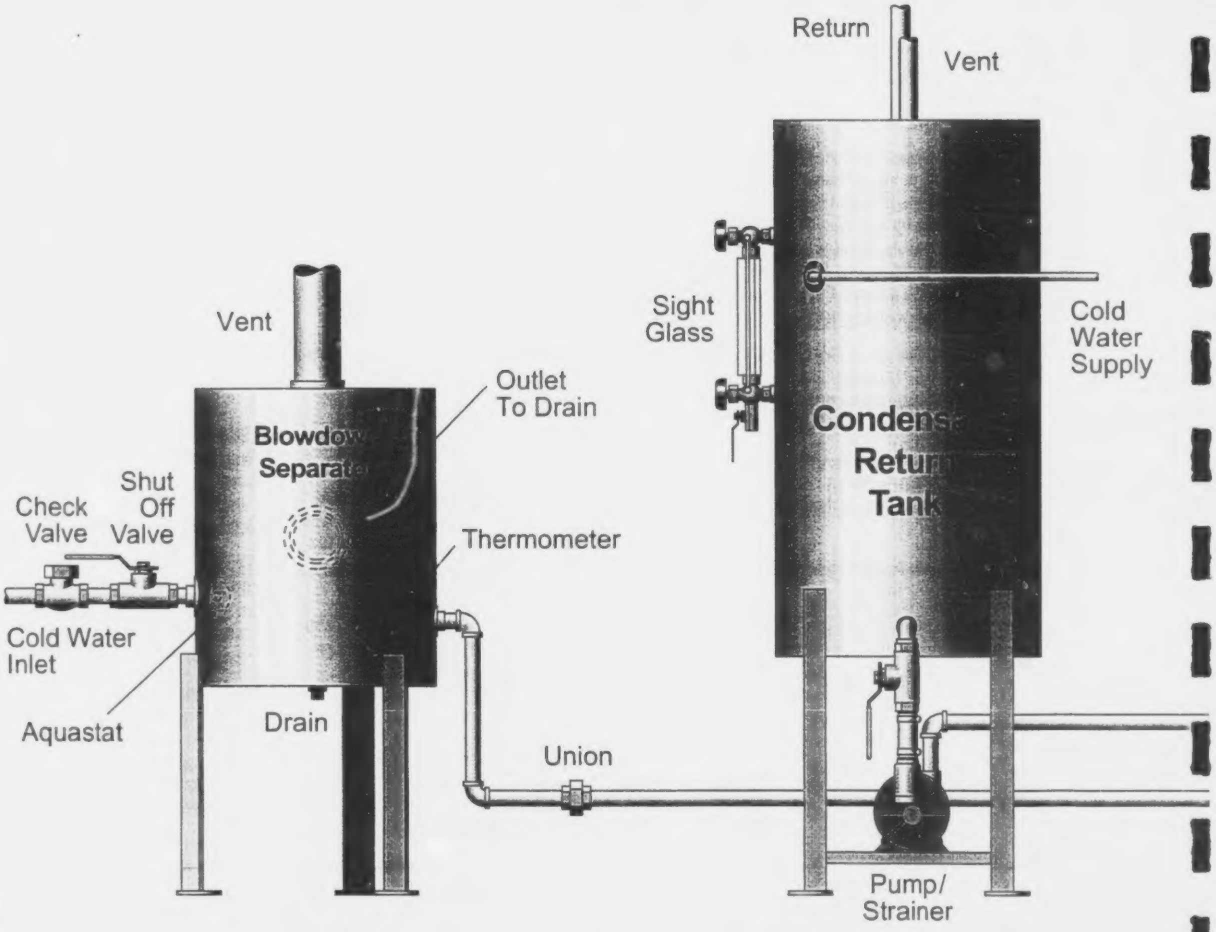
1) Be vented to a safe location, and

2) Have a capacity sufficient to satisfy boiler consumption as well as maintain proper return tank temperature.

3) Vent pipe should not be downsized (this may cause pressure build up in the condensate tank).

4) Return pipes must not be insulated. This can cause overheating the return system, causing a vapor lock in the pump.

5) See Return System Instruction Manual for detailed instructions.


Return
Vent
Sight Glass
Cold Water Supply
Condensate Return Tank
Vent
Outlet To Drain
Blowdown Separator
Shut Off Valve
Check Valve
Thermometer
Cold Water Inlet
Aquastat
Drain
Union
Pump/ Strainer

Description/Instructions

NOTE

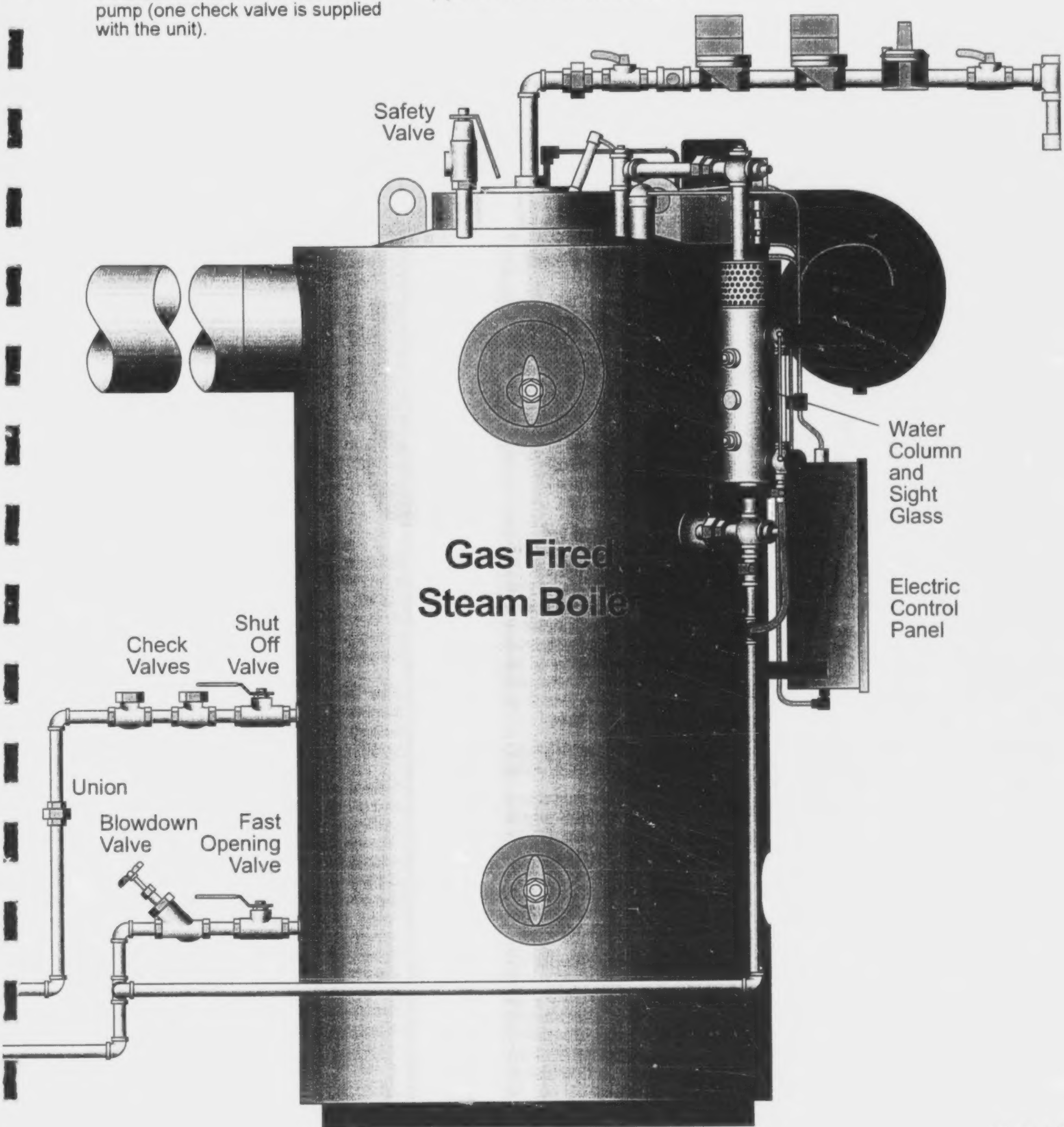
Care should be taken to ensure that the blow off receptacle used meets the regulations covering such vessels. If in doubt consult a Fulton Representative for advice.

a) Make sure two check valves are installed between the boiler and pump (one check valve is supplied with the unit).

b) In a closed system an end of the line trap should be installed.

c) There are three blow off valves on the boiler: the main valve at the rear of the boiler, the gauge glass blow off valve, and the water column blow off valve. The boiler blow off valve supplied with the boiler should be screwed to the blow off pipe at the rear of the boiler and connected to a blow off receptacle of approved design.

All these procedures should be done in accordance with state and/or local codes. The water column blow off valve and the gauge glass blow off valve should be connected to the main blow off line.


Safety Valve
Water Column and Sight Glass
Gas Fired Steam Boiler
Electric Control Panel
Check Valves
Shut Off Valve
Union
Blowdown Valve
Fast Opening Valve

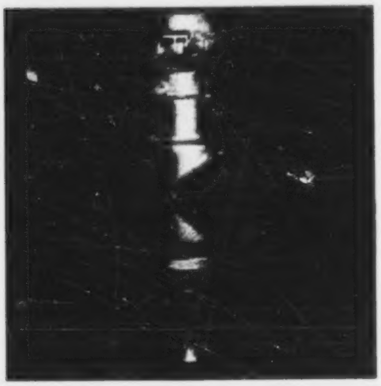
Description/Instructions

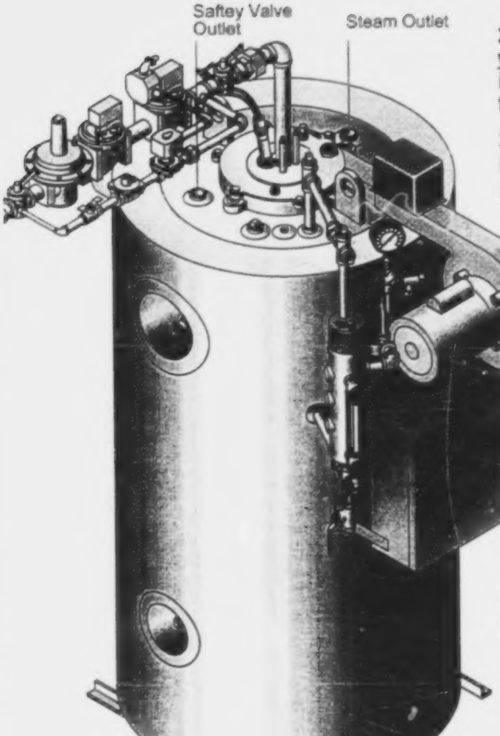
Boiler Installation

The Steam Supply — Pipe the steam supply line from the top right side of the boiler.

The Steam Safety Valve

1) Before installing, be sure that all pipes and connections have been blown clean. Pipe compound or dope is used on external threads only. Be sure inlet of valve is free of any foreign material.





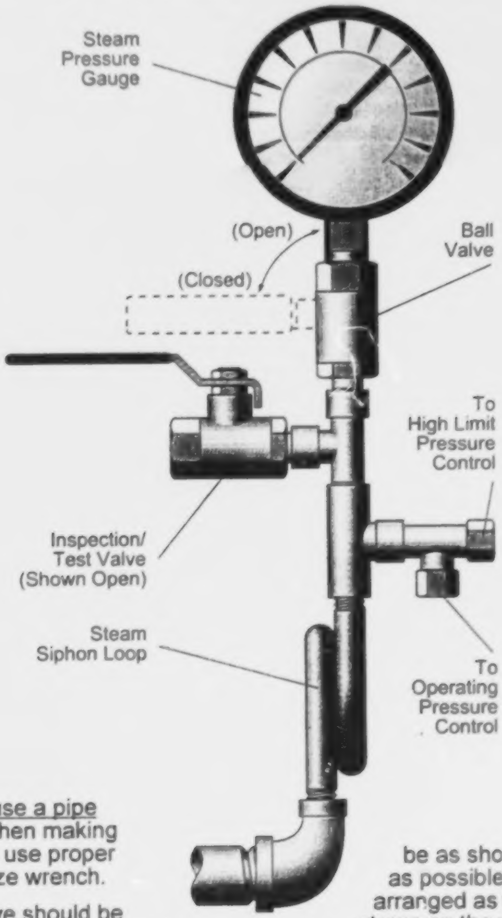
2) Do not use a pipe wrench! When making installation, use proper type and size wrench.

3) The valve should be installed in a vertical upright position in the connection provided on the top left side of the boiler with no unnecessary intervening pipe. Under no circumstances should there be a shut off valve or restriction of any kind between the safety valve and the connection provided.

4) Do not cap or plug drain hole in the side of valve body.

5) Since the purpose of this safety valve is to protect against an overpressure situation, it will loudly discharge hot steam in doing so. Therefore, it is recommended that a discharge pipe be securely installed and run to a safe point of disposal.

6) When a discharge pipe is used, it must be of a pipe size equal to or greater than that of the valve outlet. Use schedule 40 discharge pipe only. Do not use schedule 80, extra strong or double extra strong discharge pipe or connections. It must be as short and straight as possible and so arranged as to avoid undue stress on the valve. It must have an ample provision for draining condensate at or near the valve outlet. It must terminate freely to atmosphere with no intervening valve of any description and it must be securely anchored and supported.

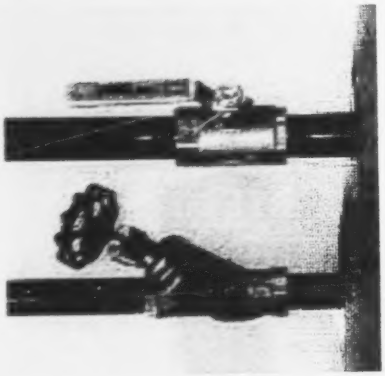

Steam Pressure Gauge
(Open)
(Closed)
Ball Valve
To High Limit Pressure Control
Inspection/ Test Valve (Shown Open)
Steam Siphon Loop
To Operating Pressure Control

The Steam Pressure Gauge Assembly — The gauge should be facing front towards the panel box and/or operator of the boiler.

Except as noted, each assembly or any of its component parts may be oriented, other than as shown to provide improved operating clearances and/or view of gauge. Before installing steam gauge on the siphon, add a small amount of water to the siphon to create a water seal to buffer the gauge element. This must be done to prevent inaccurate pressure readings and /or premature failure of the gauge. Install the steam gauge into the siphon on the water column.

Description/Instructions

The Blow-Off Valve — There are two blow off valves on the boiler: The main valve at the rear of the boiler and the water gauge glass blow off valve. The boiler blow off valve supplied with the boiler should be screwed to the blow off pipe at the rear of the boiler and connected to a blow off receptacle of approved design. This should be done in accordance with state and local codes.



The Feed Water Piping

1) Provisions must be made for adequate water supply and properly sized piping. Piping must be done in compliance with all local codes. The following chart may be used as a guideline for sizing.

BHP	Minimum Water Supply Piping Size	
	Inches	Millimeters
4	1/2	12.5
6	1/2	12.5
9.5	1/2	12.5
10	1/2	12.5
15	3/4	19
20	3/4	19
30	1	25
40	1	25
50	1	25
60	1	25

2) When feeding the boiler using a return system, the city water pressure should not exceed 40 PSI. A pressure reducing valve should be installed a head of the return tank when above this pressure.

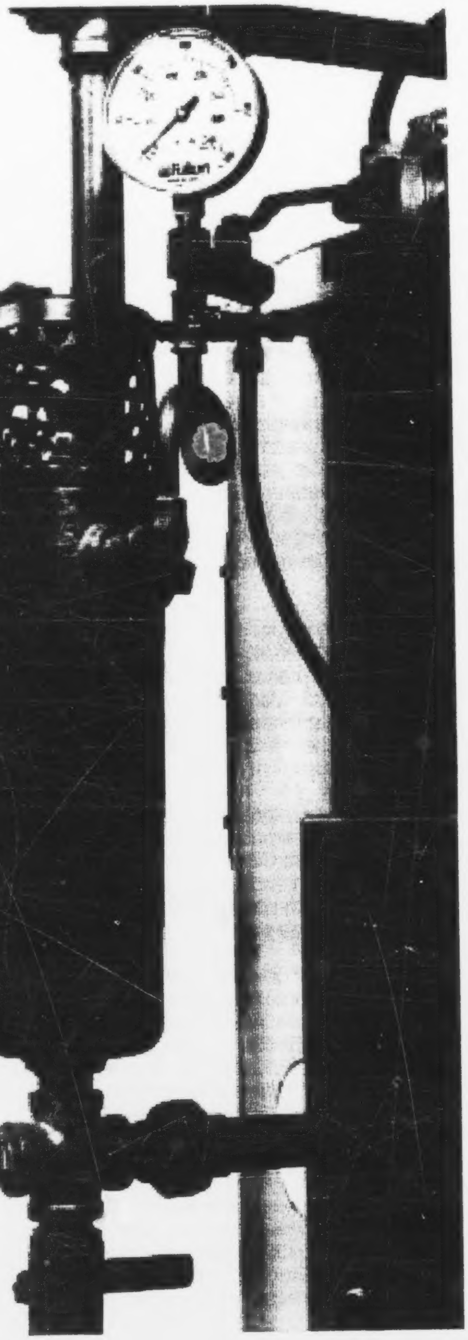
3) It is important that all piping be lined up and not forced into place. It is recommended that you begin piping at the pump. If the lines are ended at the pump, particularly if the last piece is cut too short or long, the pump will be forced to meet the pipe and strain or distortion will result.

4) Do not use the pump as a piping support. It is critical that the pipe be independently supported near the pump so no strain will be transmitted to the unit.

5) Connect the feed water stop valve to the feed water pipe at the rear of the boiler and pipe it to the return system.

The Water Column

Install the piping from the water column and water gauge glass to a safe blow-off point.



Description/Instructions

Water Gauge & Gauge Glass Installation instructions

NOTE

Only properly trained personnel should install and maintain water gauge glass and connections. Wear safety glasses during installation. Before installing, make sure all parts are free of chips and debris.

NOTE

Keep gauge glass in original packaging until ready to install.

1) Verify the proper gauge has been supplied.

2) Examine the gauge glass and packings carefully for damage before installation. Do not use the glass if it contains any scratches, chips, or any other visible signs of damage.

3) Do not subject the gauge glass to bending or torsional stresses.

4) Apply teflon tape or pipe dope to pipe threads. Install top gauge fitting (fitting without a drain valve) into the uppermost tapping. Wrench tighten the fitting until it is snug and the glass outlet is pointing at five o'clock (about 1/8 turn from its final downward vertical position).

5) Install the bottom gauge fitting (the fitting with a drain valve) until it is snug and the glass outlet is pointing directly upward. Verify top and bottom fittings are threaded into the tappings the same number of turns (distance A=distance B).

6) Remove glass packing nut, friction washer and glass packing from the fittings, and place them, in the same order, on to both ends of the gauge glass. Push both packings about an inch up the gauge glass.

7) Gently insert one end of the glass into the top gauge fitting. Keeping the glass inside the top fitting, gently rotate the top gauge fitting clockwise until vertically aligned with the bottom gauge fitting, then inset glass into bottom fitting until glass bottoms out on the shoulder inside the bottom fitting.

8) Carefully raise glass about 1/16" and slide lower glass packing down until the glass packing contacts the lower gauge fitting. DO NOT allow the glass to remain in contact with any metal!

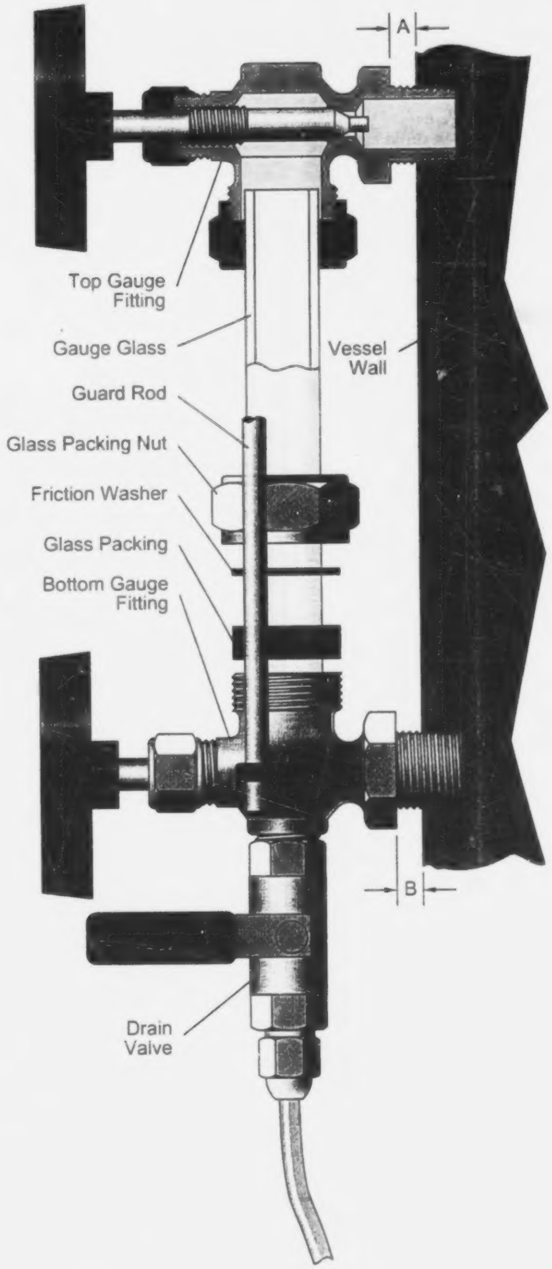
9) Carefully slide upper glass packing up as far as possible.

10) Hand tighten both glass packing nuts, then tighten 1/2 turn more by wrench. Tighten only enough to prevent leakage. DO NOT OVER TIGHTEN! If any leakage should occur, tighten slightly, a quarter turn at a time, checking for leakage after each turn.

11) Install the protective guard, and utilize automatic ball checks where necessary to help prevent injury in case of glass breakage.

WARNING

Improper installation or maintenance of gauge glass and connections can cause immediate or delayed breakage resulting in bodily injury and/or property damage.



Description/Instructions

Water Supply

a) Feed water contains solids and dissolved gases. These may promote incrustation of scale; foaming, priming, surging, and solids in steam; corrosion and pitting; or caustic embrittlement. To prevent this, feedwater must be studied individually and treated accordingly by reputable professionals specializing in this field. It is strongly recommended that a competent water treatment company be consulted prior to the installation of the boiler.

b) The purpose of this treatment should be to provide quality feedwater to the boiler such that corrosion and deposition in the boiler will be minimized. Dissolved oxygen, high chloride levels and low pH can all be major causes of corrosion. Untreated hardness is the major cause of deposits. Poor quality feedwater requires increased blow off and increased chemical treatment costs to prevent boiler corrosion and scaling.

c) One way to lower the amount of dissolved oxygen in the boiler feed water is the sparge tube option. This option injects live steam into the feedwater to increase the water temperature to 180 degrees F (82 degrees C) which removes oxygen from the water.

d) Chlorides can be controlled by increasing the number of blow downs per day from one to four.

e) The Fulton Warranty does not cover damage or failure that can be attributed to corrosion, scale or dirt accumulations. Oxygen is a corrosive. See the Warranty Section of this manual for full details.

Recommended Water Treatment

a) Following are recommendations for feed water and boiler water. Contact your local water treatment professional for testing and treatment recommendations. It is very important that a strict water treatment program be followed.

Feedwater:

Dissolved Oxygen	less than 0.05 ppm
pH Value	9-11 (tested at room temperature)
*Hardness	less than 70 ppm in the form of $CACO_3$
Oil	none
Suspended Solids	none
Organic Matter	less than 5.0 ppm
Chloride	less than 50.0 ppm
Total Dissolved Solids	less than 300ppm

Boiler Water:

Phosphate	30 to 50 ppm in the form of PO_4
Alkalinity	less than 300 ppm in the form of CACO3
Chloride	less than 500 ppm
pH Value	9 to 11 tested at room temperature)
Total Dissolved Solids	400 to 2,000 ppm
Iron	1 ppm maximum
Silica	180 ppm max. as SiO_2
Hardness	less than 50.0 ppm
Dissolved Oxygen	none

ppm = parts per million; CACO3=Calcium Carbonate; PO4=Phosphate; SiO2=silicon dioxide; * 1 Grain Hardness = 17.118 ppm Therefore: 70 ppm = 4.10 grains hardness

b) It is critical that the boiler pH be alkaline (9-11) whenever water is in the boiler. Solids that enter in with the feed water concentrate in the boiler. Daily boiler blow down is recommended to prevent corrosion and/or deposits from forming.

Glossary of Water Supply Corrosives and Inhibitors

Dissolved Oxygen: Oxygen that is dissolved in the feedwater will cause the steel in the boiler and the feedwater system to be attacked by the water in a manner described as "pitting". The pits that are produced can vary from tiny depressions to holes large enough to penetrate the boiler metal and are usually covered with tubercles of iron oxide. Once pitting starts, it may be extremely hard to arrest. Pitting can proceed at a surprisingly rapid rate and can occur not only in the boiler proper, but also in pre-boiler equipment such as economizers, feedwater heaters, and feedwater lines.

Sodium Sulfite: Its purpose is to chemically remove the dissolved oxygen left in the feedwater.

Sodium Sulfite reacts chemically with dissolved oxygen, producing sodium sulfate. Since it is desirable to remove dissolved oxygen from the feedwater before it reaches a boiler. Sodium sulfite is best introduced continuously at some suitable point in the feedwater system. Chemical residual control is based on the maintenance of a specific excess of sodium sulfite in the boiler water. The essential requirement being to maintain in the feedwater at all times slightly more than enough sodium sulfite to consume all of the dissolved oxygen. When sodium sulfite is not fed continuously, protection of the boiler against oxygen attack must depend on the reserve of sodium sulfite that is present in the boiler water. In this case, it is important that the feedwater and the boiler water are mixed thoroughly and as quickly as possible so that boiler water sodium sulfite may consume feedwater oxygen before the latter can cause damage to the boiler.

Sulfite as a treatment represents a second line of defense against oxygen corrosion. A vigorous maintenance program to safe guard against oxygen leakage into the pre-boiler system should be followed.

Suspended Solids: Suspended solids are the undissolved matter in water, including dirt, silt vegetation, and any other insoluble organic matter. Normally suspended solids are expressed in terms of turbidity.The presence of suspended solids in cooling water can increase impingement type corrosion. Suspended solids may also deposit in low velocity areas and create differential aeration cells. Pitting can result. The most common cause of high suspended solids is high hardness feedwater. Of the agents which cause foaming, suspended solids probably have the least effect. Reasons for the increased hardness or other suspended solids should be determined.

In line filters, or various types of pretreatment can be used to lower the suspended solids level. Various polymers assist in holding solids in suspension.

Alkalinity: Alkalinity is the capacity of a water to neutralize acids. Common water alkalinities consist of bicarbonate, carbonates, hydroxide, phosphate, and silicate. These alkalinities, especially bicarbonates and carbonates, break down to form carbon dioxide in steam, which is a major factor in the corrosion on condensate lines. High alkalinity also causes foaming and carry over in boilers.

Both foaming and carry over cause erratic boiler operation. When foaming occurs an anti-foam should be added or increased. The reason for the high alkalinity should be determined. It may result from lack of sufficient blow off. Pretreated makeup water and condensate should also be checked. Quite often the source of alkalinity is an overdose of alkaline internal water treatment chemical.

pH: pH is a measure of the degree of acid or base of solution. Normal pH ranges of 6.5-9.0 will have little influence on the corrosion rate of cooling waters. If for some reason, pollution, etc., the pH is lowered into the acid range, increased corrosion can be expected. The solution lies in determining the cause of the low pH and correcting that condition. A low pH can result in corrosion of metals, while a high pH can result in scale formation.

In order to control boilers and equipment used for the external treatment of make up water, it is essential that reliable pH measurements be made.

Phosphates: Ground or surface waters seldom contain large amounts of phosphates. If present, it generally indicates fertilizer runoff or pollution. Phosphate from raw water can be the cause of scale problems in open recirculating cooling water systems after the water is concentrated.

Chlorides: Chlorides are involved in most cooling water corrosion cells. Other factors being equal, it can be assumed the higher the chloride content, the more corrosive the water. When pits or cracks occur on stainless steel or other metals, chlorides are always suspect.

High chloride levels can cause severe corrosion. Corrosion from chlorides can be controlled by increasing the amount of corrosion inhibitor or changing to a more effective inhibitor.

Oil: Oil is not a natural constituent of boiler water; still it can frequently enter a system through leaks in a condenser or other heat exchanger. Oil can also enter a system through the lubrication of steam driven reciprocating equipment. Whatever the source, the presence of oil in boiler water is undesirable. Oil can act as a binder to form scale. In high heat-transfer areas oil can carbonize and further contribute to the formation of scale.

Foaming is one indication of oil in boiler water. Its presence can also be confirmed by first shaking a bottle containing boiler water. If oil is present foam will result. To ensure the foaming is being caused by oil, add a small amount of powdered activated carbon to the bottle containing the boiler water and shake. Little or no foam will appear if the foaming is caused by oil.

Often oil in boiler water will originate in the condensate. This contaminated condensate should be directed to the sewer until the source of the oil is determined and corrective steps taken.

Silica: Silica in boiler deposits is usually combined with other constitutents. Silicates form a number of different scale complexes with calcium, magnesium, aluminum, sodium, and iron. Since there is at present no effective dispersant for silicate deposits, the scale problem can be alleviated by maintaining close control of calcium, aluminum, and iron as well as silica.

Iron (oxides): Iron in any of its oxide or complex forms is undesirable in boiler water. It is very difficult to disperse so that it can be removed the bottom blow off lines.

Iron in its various forms can originate in the raw water makeup, condensate return water, or form directly in the boiler as a result of corrosion. Most iron oxide originates outside the boiler. It does not concentrate in the boiler and it tends to collect in stagnant areas. If a boiler is using raw water makeup, iron is almost certain to be a major component of developing scale.

Water Hardness: Water hardness is the measure of calcium and magnesium content as calcium carbonate equivalents. Water hardness is a primary source of scale in boiler equipment.

Feedwater: Feedwater is the combination of fresh makeup and returning condensate that is pumped to the boiler.

Condensate: Condensate is condensed steam that is normally low in dissolved solids. Hence, it does not contribute to the dissolved solid content of the feedwater. In addition, condensate is very expensive to waste. It's been chemically treated, heated, pumped, converted to steam, and condensed. This costs money and when condensate is returned to the boiler, money is saved.

Description/Instructions

Electrical Requirements

a) Connect wiring as shown in the wiring diagram which is furnished inside the electrical control panel box.

b) Be sure to install a separate fused disconnect for each. The disconnects should be installed in compliance with the NEC (National Electric Code) and all local codes.

c) Connections for an optional audible alarm are provided in the control panel and are clearly indicated on the diagram.

Fresh Air Supply for Boiler

a) It is most important to provide free access of air to the boiler. To burn fuel properly, it requires one square inch opening of fresh air for every 3,000 BTU input of fuel. (6.4cm^2 for every 756 Kcal).

b) Proper ventilation of the boiler room is essential for good combustion. **Install two fresh air openings,** one at a low level (24"—610mm from floor) and one at a higher level in the boiler room wall.This will provide a flow of air to exhaust the hot air from the boiler room. **Room temperature not to exceed 100°F.**

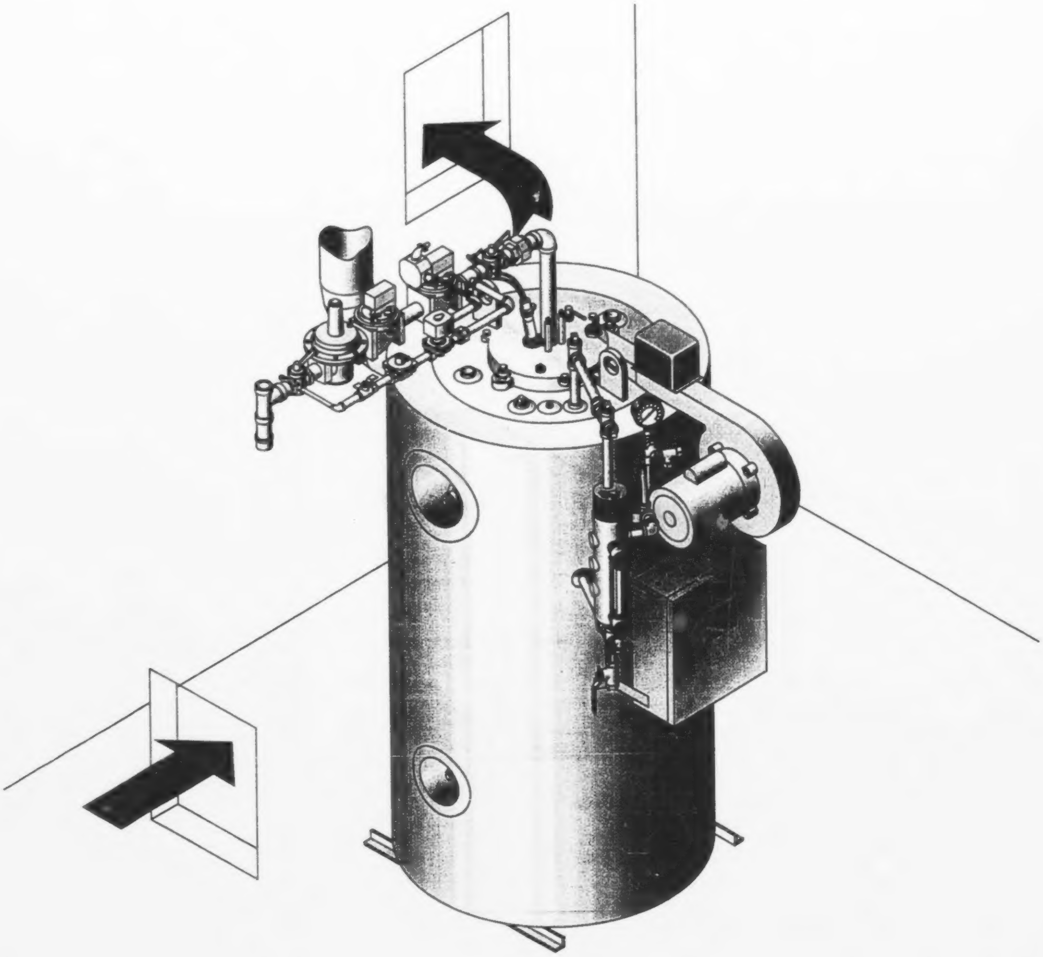
c) The following openings are recommended for each size boiler:

Make Up Air Openings

BHP	FT^2	M^2
4	1	.09
6	1	.09
10	1	.09
15	1.5	.14
20	4	.37
30	4	.37
40	5	.46
50	5	.46
60	7.5	.69

Be sure total BHP = proper make up air opening size. For instance if you have three 10 BHP boilers, it is a total BHP of 30, and the 30 BHP make up air opening size is recommended.

These measurements are subject to state and local regulations. The installation of exhaust fans in a boiler room is not recommended. An exhaust fan, or similar equipment can create down draft in the stack or restrict the burner's air supply which will result In poor combustion. It is essential that only fresh air is allowed to enter the combustion air system. Foreign substances, such as combustible volatiles and lint, in the combustion system can create hazardous conditions.



Description/Instructions

Conventional Venting

a) The stack should rise continuously to the connection with the chimney, and should contain no more than two bends at 45 angles or less. If required as the result of space limitations, one 90 elbow can be fitted at the back of the boiler. There should be two feet of straight, horizontal flue before any bends or turns. Any alternative stack arrangement must supply a negative .02 to.04" W.C. pressure (0.508 to 1.016 mm) with the burner off.

b) The run in the total distance of stack ducting, as measured in a straight line from the outlet of the boiler to the outlet of the stack, should not exceed 25% of the rise. With the exception of a duct run described in Item a, horizontal sections of ducting must be avoided, and should not exceed four feet of total run.

c) The stack and chimney material shall comply with all local codes.

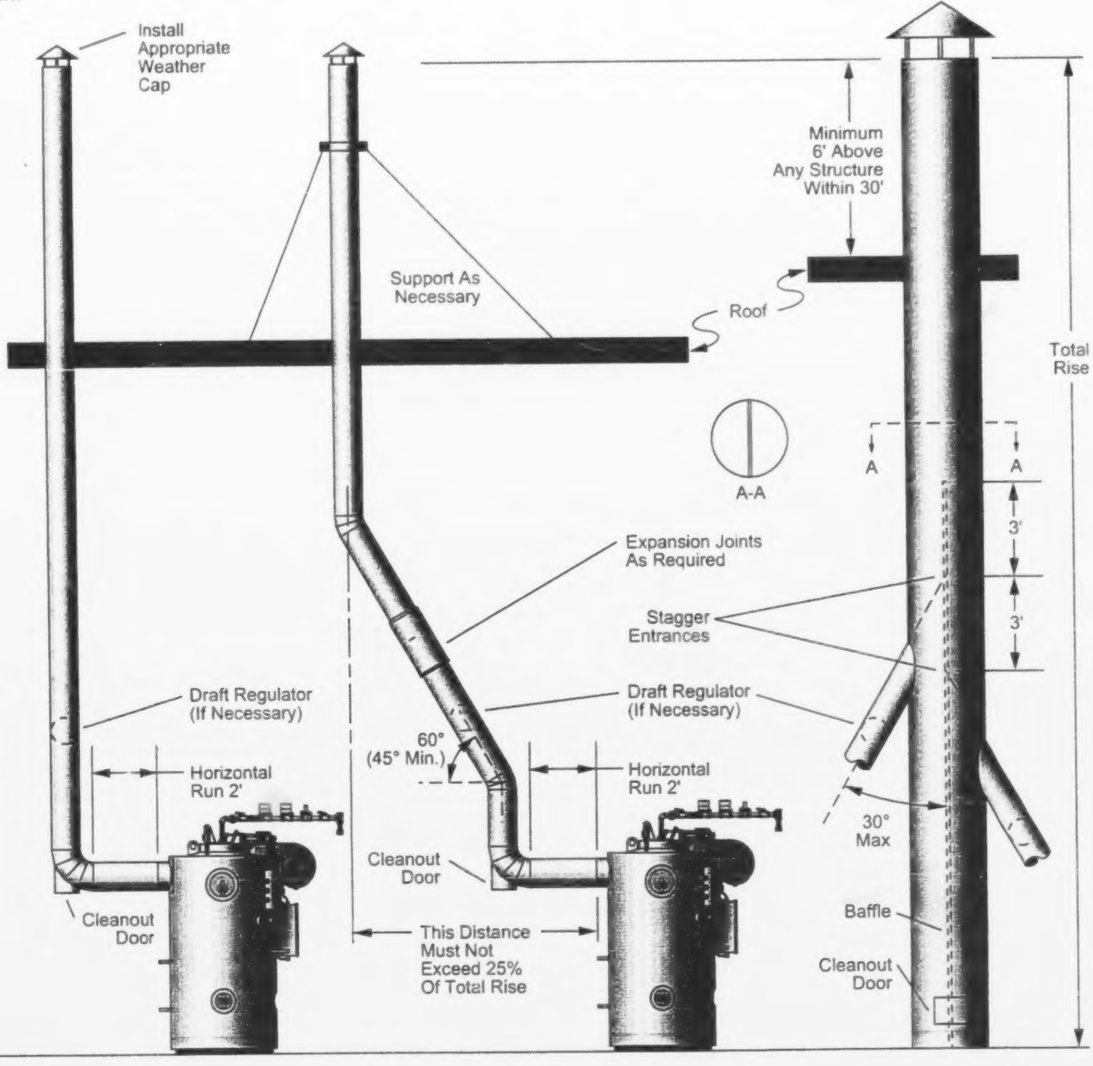
d) Adequate provision must be made for the support of the weight of the chimney and stack to avoid having too great a load imparted to the flue outlet connection of the boiler.

e) The proper flue size and draft control is most important for proper burner operation. The flue must be as large or larger than the outlet on the boiler. Avoid flue piping and elbows by placing the boiler as close as possible to the chimney.

f) A mechanical draft regulator should be installed in the flue outlet. Do not install the draft regulator prior to the first turn of the flue.

BHP	Boiler Flue Size	
	Inches	Millimeters
4	6	152
6	6	152
9.5	6	152
10	6	152
15	8	203
20	10	254
30	12	305
40	12	305
50	12	305
60	12	305

g) The installer should check the draft with a meter at negative .02 to .04" W.C. pressure (0.508 to 1.016 mm) with the burner off.


Install Appropriate Weather Cap
Support As Necessary
Roof
Minimum 6' Above Any Structure Within 30'
Total Rise
A-A
A
A
3'
3'
Expansion Joints As Required
Stagger Entrances
Draft Regulator (If Necessary)
Draft Regulator (If Necessary)
60° (45° Min.)
Horizontal Run 2'
Horizontal Run 2'
30° Max
Cleanout Door
Cleanout Door
Cleanout Door
Baffle
This Distance Must Not Exceed 25% Of Total Rise

Description/Instructions

Exhaust Side Wall Venting (UL and MEA Approved- MEA File Number 68-79-E Vol. 2 **)**

a) Boilers for which sidewall venting may be utilized are No. 2 oil, natural gas, or combination No. 2 oil and natural gas,sizes 4 to 30 H.P. The following criteria is required for installations using sidewall venting:

1) Flue vent piping shall be pitched upward at 1/4" per foot of length.

2) A U.L. Approved draft fan must be installed to provide sufficient draft (-.02 to -.04 inches WC pressure - 0.508 to -1.016 mm) to safely vent the products of combustion.

3) The draft fan should be located as close to the flue outlet as possible.

4) Draft regulation sufficient to lower the draft to between -.02 and -.04 inch WC pressure (-.508 to -1.016mm) may be required. The draft regulator(s) must be between the boiler and draft fan.

5) The draft fan shall have an air flow proving switch wired in series with the boiler air safety switch.

6) The sidewall vent total length from boiler exhaust to termination shall not exceed 35 feet (10.7 m) with 4 elbows maximum.

Combustion Air Intake (UL and MEA Approved- MEA File Number 68-74-E Vol. 3 **)**

a) Vertical boilers as described in MEA 68-79-E Vol. 3 applied with combustion air intake assembly. This shall be applicable only to gas fired units, sizes 4-30 boiler horsepower. The following criteria is required for installations using combustion air intake assemblies.

1) Outside air intake inlet shall be equipped with a vent cap in order to prevent flame blow out from excessive wind. This vent cap shall have a minimum cross sectional opening equal to an 8 inch vent pipe.

2) All intake ducting shall have a cross sectional area equal to or greater than 50 square inches.

3) A mesh screen shall be affixed to the air inlet with openings of approximately 1/2" x 3/4".

4) The total length from outdoors to the boiler intake shall not exceed 35 feet (10.7 m) with four elbows maximum.

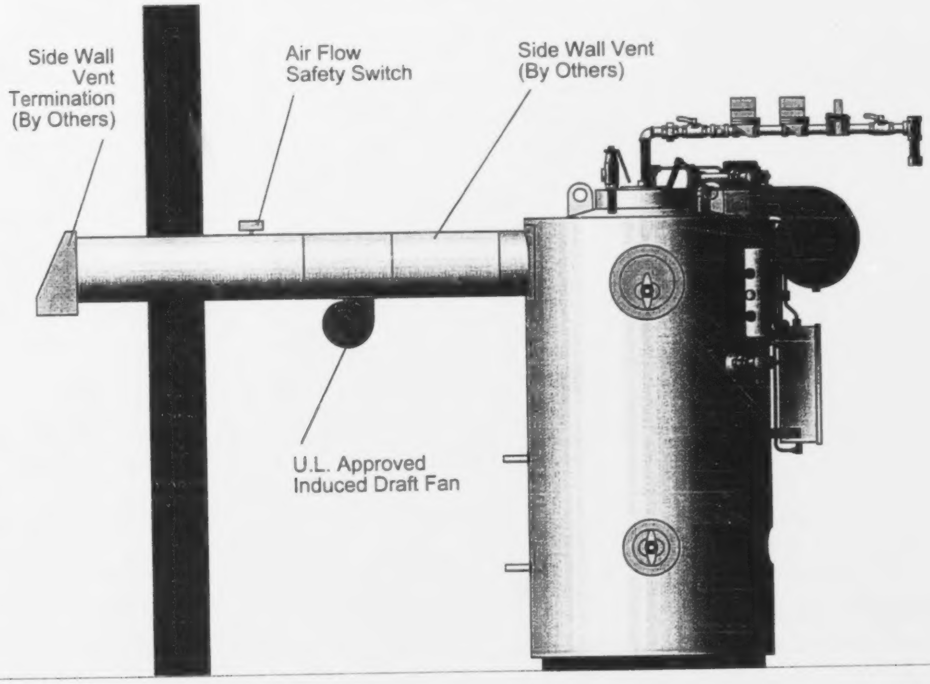
Corrosion of flue pipe

a) In the case of a combustion flue pipe, acid may develop over a long period of time by the following process. Chlorine containing gases, such as halocarbon refrigerants, carbon tetrachloride, trichloroethylene, or perchloroethylene, when drawn into combustion air are broken down into elemental chlorine gas which exits up the flue pipe. If the flue pipe is cold, as it would be if the combustion process had been off for some time, the water vapor condenses in the flue pipe during the first few minutes of ignition and the chlorine in the combustion gas dissolves in the water forming hydrochloric acid. As the combustion system flue line increases in temperature, the water vapor no longer condenses because the flue temperature is above the dew point of the combustion gas.

The combustion gas then dries out (dehydrates) the hydrochloric acid solution leaving behind dry chloride salt.

b) When the next cold start-up occurs, the process repeats except that more and more chloride collects and concentrates along the flue. As the quantity of chloride increases it does not dehydrate completely as the flue heats up and a corrosive poultice develops which attacks the steel and will also attack the boiler.

c) Concentration levels of only a few ppm of chlorine containing compounds in combustion air can produce serious corrosion over long periods of time. High chlorine containing compounds such as carbon tetrachloride or perchloroethylene would be prime suspects .


Side Wall Vent Termination (By Others)
Air Flow Safety Switch
Side Wall Vent (By Others)
U.L. Approved Induced Draft Fan

Description/Instructions

Installation Check Points

1) Make sure all piping connections are complete and tight.

2) Make sure the pressure controls are adjusted properly.

3) Make sure all electrical connections in the control panel box, the water column, and elsewhere are secure.

4) Make sure the door in the boiler room is closed. Combustion air contaminates can cause damage to the boiler jacket and stack.

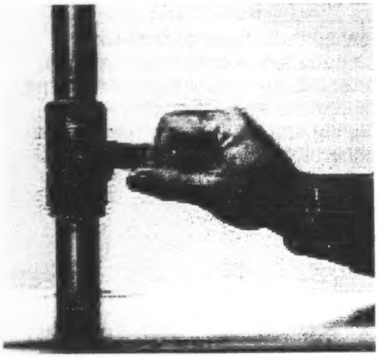
NOTE

After installation is complete and prior to operation the pressure vessel should be cleaned.

Cleaning the Pressure Vessel

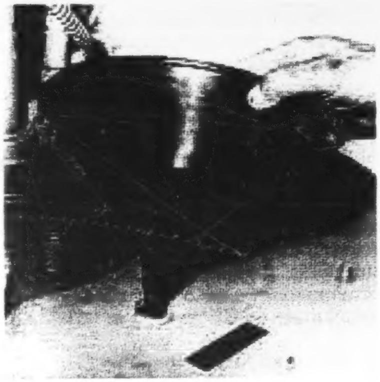
a) After the boiler has been installed and before it is placed in service it is advisable to purge the pressure vessel of any oil film,dirt, or other impurities. Clean the pressure vessel as follows:

1) Isolate the boiler from the system by shutting off the main steam valve.



2) Remove the steam safety valve.

3) Mix washing soda with water in a one-gallon container and pour it into the boiler through the steam safety valve opening.

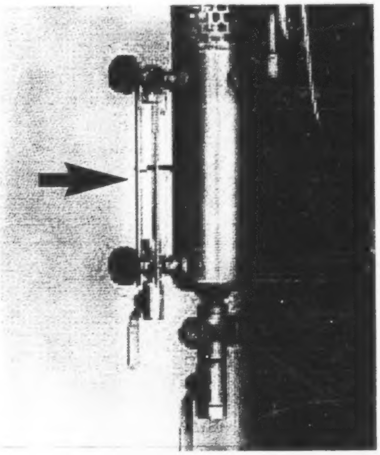


4) The mixture of washing soda to water is as follows:

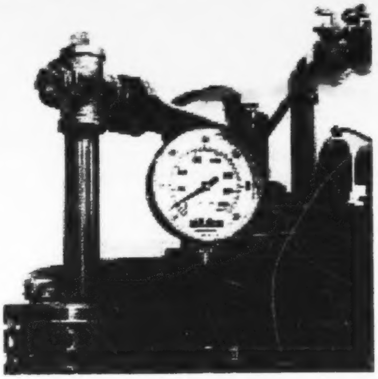
Boiler Size	Soda
4 - 6	1 lb. (454g)
10 - 15	2 lb (908g)
20 - 30	3 lb (1362g)
40 - 50	3-1/2 lb (1589g)
60	4 lb (1816g)

5) Replace the steam safety valve.

6) Fill the boiler with water. Water level is about center in the water gauge glass.



7) Generate 15 PSI (1.054 kg/cm^2) of steam and shut off the boiler. Allow this hot solution to remain in the boiler for 10 minutes.



8) Drain and flush the boiler twice with fresh water.

9) To remove all the oil and dirt from the main steam and the condensate return lines, allow the returns to go into a floor drain or a safe discharge point for the first week of operation.

CAUTION

Do not store halogenated hydrocarbons near or in the boiler room.

In general, ensure that the boiler area is in conformance with established boiler room requirements. Review national and local codes.

As a final checkpoint, again,

Water Treatment

We cannot emphasize enough the importance of proper water treatment: Water analysis should be made by a competent water treatment concern and their recommendations should be followed.

3

Operation

Starting the Gas Fired Boiler

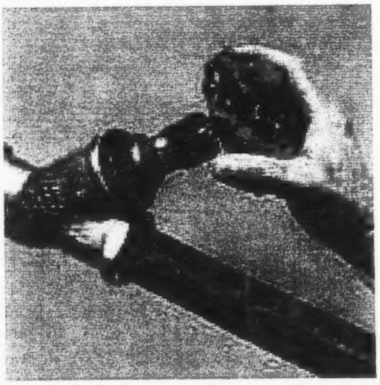
Stop! Make sure you have read and followed all previous safety information.

Check with local authorities where approval for start-up is required. In some localities, final inspection of services may be required.

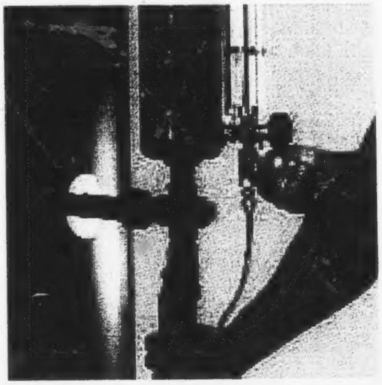
In general, ensure that the boiler area is in conformance with established boiler room requirements. Review national and local codes.

Carry out the following procedure on the initial start up of the boiler and on every subsequent occasion when restarting the boiler after a shut down.

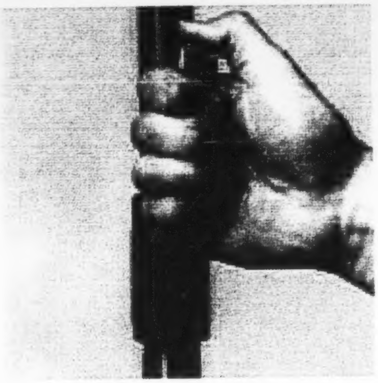
1) Close the blow-off valve.



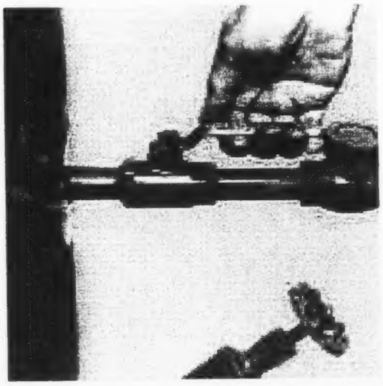
2) Close the water gauge drain valve.



3) Open main steam stop valve at the top of the boiler.



4) Open the water feed valve on the boiler.



5) Open valves on makeup water line to return if return system is used.

6) Place feedwater pump fused switch in the "on" position.

NOTE

a) The fused disconnect switch that controls the feed water pump should be kept in the "on" position at all times during the boiler operation as well as during the non-operating period of the boiler.

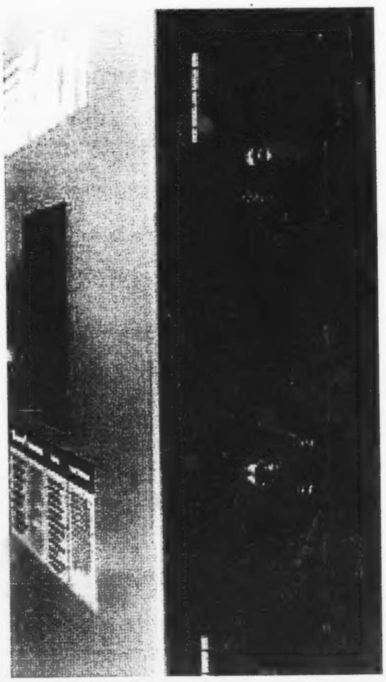
b) This switch should be turned "off" only when repairs or adjustments should be made.

NOTE

The pump will continue to operate until the water reaches the correct level in the boiler. This level is approximately the center of the water gauge glass.

7) Activate the boiler power on switch, located on the side of the panel box.

8) With the unit full of water the low water safety relay(s) will be in a lock-out mode. Press the low water safety relay manual reset button located on the side of the control panel box.



Operation

Gas Burner Set Up

NOTE: Refer to Section LE for LOW EMISSIONS BURNERS

a) Open the manual gas cocks on the pilot and main lines of the gas head.

b) Switch on the main power to the burner. The water level relay is equipped with a manual reset. Depress the button on the box.

c) The flame programmer is the main control in the panel box. The programmer in conjunction with a sensing device, either a flame rod or a UV scanner, "supervises" the ignition sequence - proves the flame is satisfactory, and finally"monitors" the established flame. Should any fault occur, either during the ignition sequence or during normal running, the programmer will immediately go to "lock-out" and the burner will shut down.

d) When the pilot flame is established, the flame rod (or ultra-violet scanner) senses the voltage which is created in the flame between the flame rod and the gas nozzle (ground). This signal is transmitted back to the flame programmer which opens the main gas valve giving a main flame.

e) Fulton 4 - 30 h.p. natural gas fired boilers can be equipped with flame rods or UV scanners.

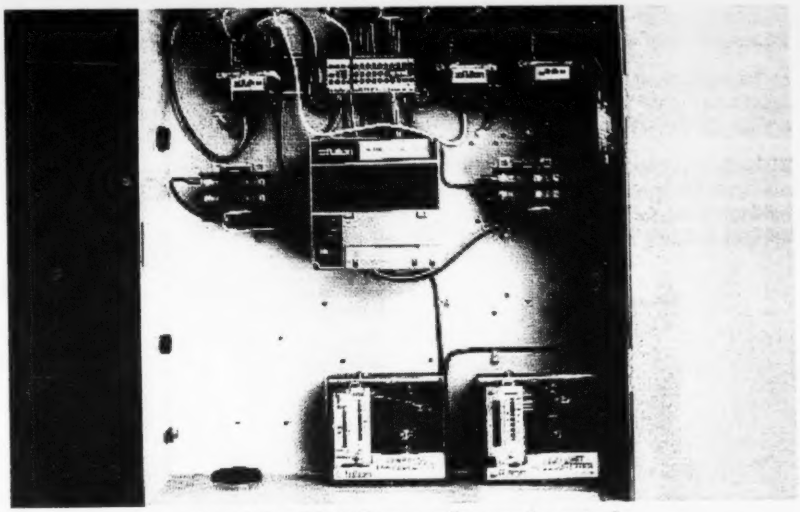
f) All Fulton propane or butane boilers and 50 and 60 HP Fulton natural gas boilers are standardly furnished with UV Scanners.

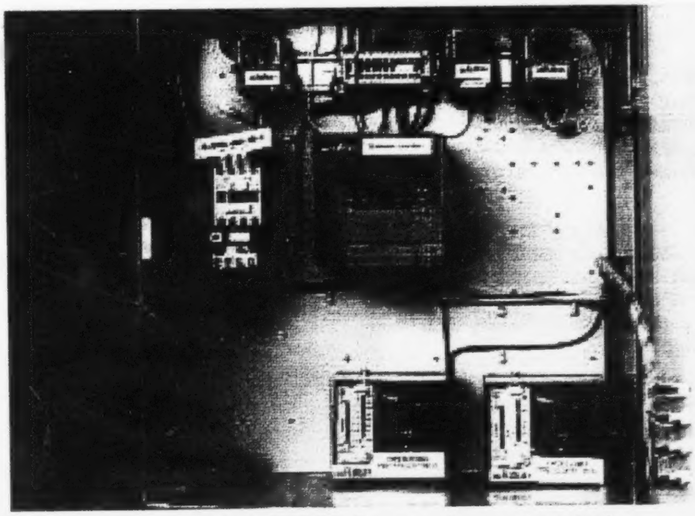
1) If the installation is new or the burner has been disassembled, the burner may not fire at the first attempt due to air which must be purged from the gas lines. This will result in the burner flame programmer going to lockout. Repeat the procedure for starting the burner.

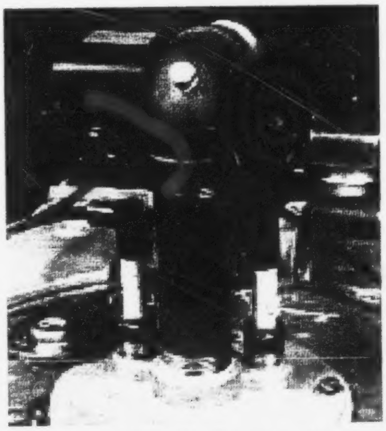
2) The main gas valve will remain open as long as there is a demand for heat and the flame is carrying a sufficient signal to the flame programmer.

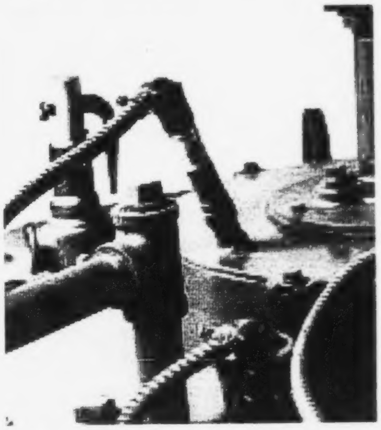
3) If the flame is not established at the start, the safety switch in the flame programmer control will open the contacts and shut off the burner.

4) Push the reset button on the control to reset. If trouble persists, it may be necessary to check the flame rod setting or the UV scanner. See Maintenance Section 4 for procedure to check flame rod setting or UV Scanner.


4-50 HP – 7895 flame safeguard control


60 HP – 7800 flame safeguard control


4-30 HP with flame rods

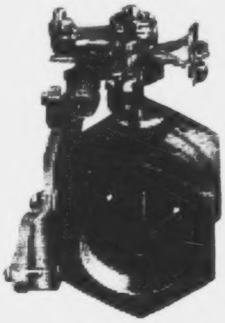

50 and 60 HP with UV Scanner

Operation

Gas Burner Set Up For Boilers Equipped with Modulation

a) Modulation is available as an option on Fulton gas fired steam boilers for 30 -100 HP units only.

b) Boilers equipped with modulation will have the linkage rod disconnected between the modulation motor and the gas butterfly valve for shipment.



c) Mount the gas train on the pipe nipple of the burner plate with the gas train inlet directly facing over the panel box. Reconnect the linkage from the butterfly valve to the modulation motor.

d) The end of the linkage arm that attaches to the butterfly valve will have a notch on both sides of it, where the swivel collar should be centered. This setting was based on factory test fire conditions.

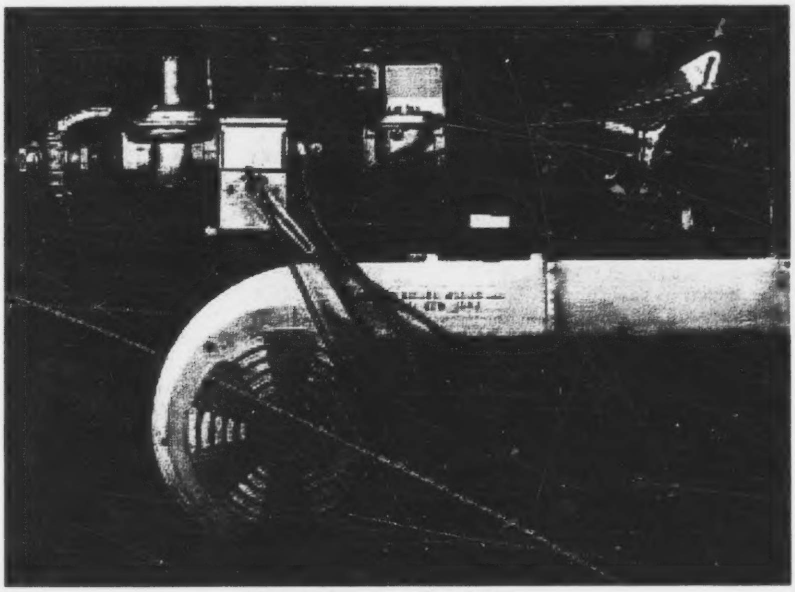
e) Combustion analysis should be done at the installation to make any changes to insure proper combustion characteristics.

f) The modulating burner will have a modulation lock switch in the panel box to enable you to lock the firing sequence anywhere along the firing rate from low to high.

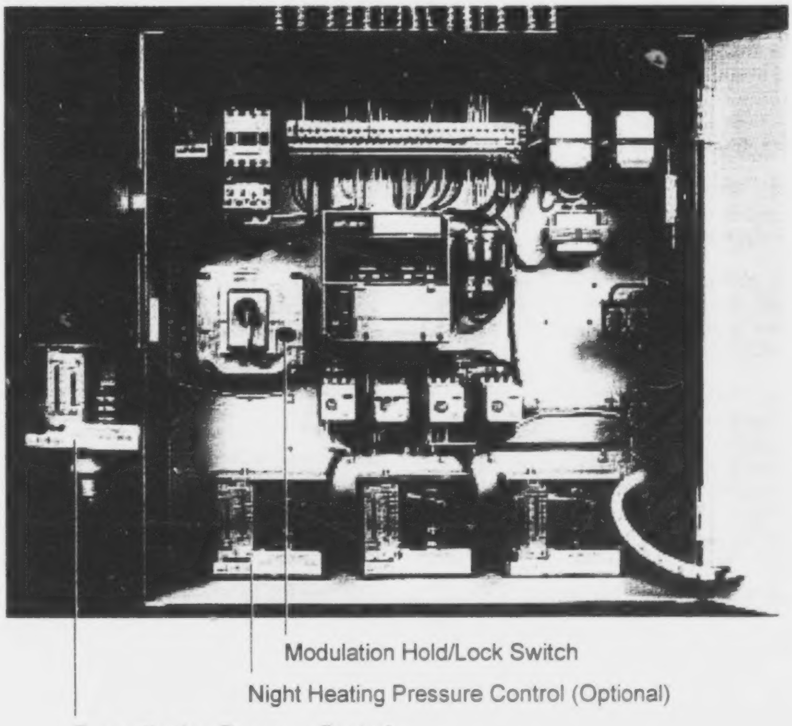
g) Depending on the combustion characteristics, it may be necessary to adjust both linkage arms. To adjust the linkages, unscrew the swivel collar and move the linkage rod in the appropriate direction.

h) Modulating burners will have a proportioning pressure control in addition to the standard operating pressure control that will send a 0-135 ohm signal to the modulation motor to adjust the firing rate. Both pressure controls should have the same setting.

i) NEMA 4 units will use a digital pressure controller with transducer as the operating pressure control which sends a 4-20 ma signal to the modulation motor to control firing rate.



Modulating Gas Fired Burner



Modulation Hold/Lock Switch
Night Heating Pressure Control (Optional)
Proportioning Pressure Control

Panel Box for Modulating Gas Fired Boilers

Operation

Gas Burner Set Up For Boilers Equipped with High-Low-Off

a) A gas fired burner equipped for high-low-off firing is available as an option on Fulton gas fired steam boilers for 30 -100 HP units only.

b) Boilers that have a high-low-off firing rate will have a linkage between the high-low gas valve and the primary air gate. This valve is equipped with a spring return.

c) The linkage will be disconnected from the gas valve for shipment.

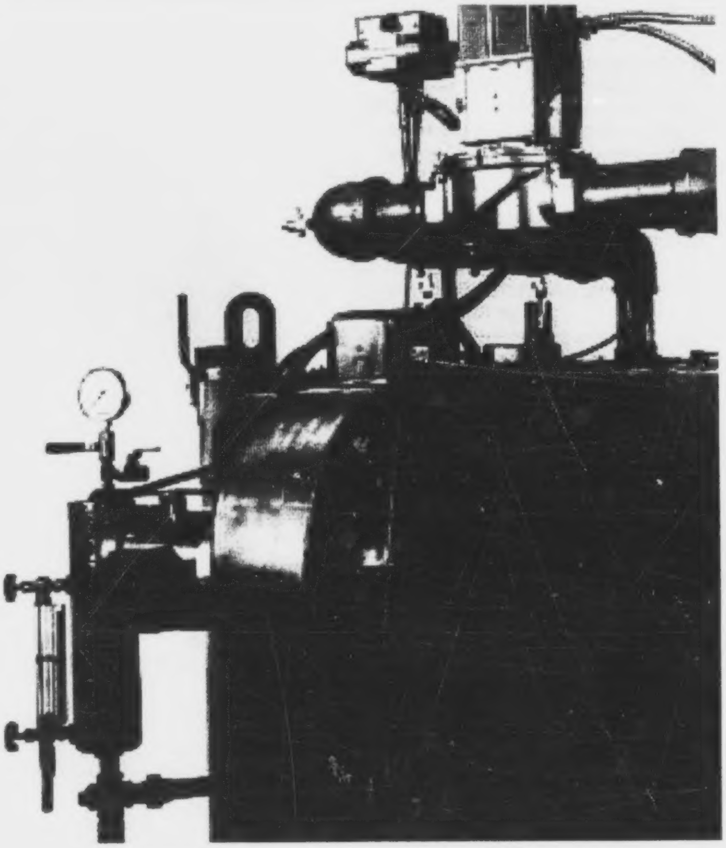
d) Mount the gas train on the pipe nipple of the burner plate with the gas train inlet directly facing over the panel box. Reconnect the linkage from the primary air gate to the high-low gas valve.

e) The end of the linkage arm that goes to the gas valve will have a notch on both sides of where the swivel collar should be centered. This setting was based on factory test fire conditions.

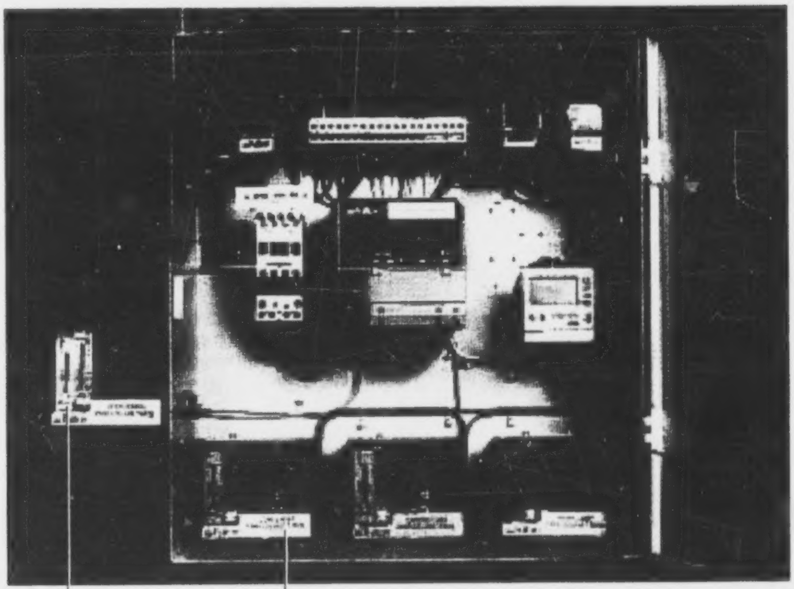
f) Combustion analysis should be done at the installation to make any changes to insure proper combustion characteristics.

g) To adjust the linkage, unscrew the swivel collar and move the linkage rod in the appropriate direction. The high-low-off configuration comes with two operating pressure controls.

h) Set the low operating pressure control to approximately 60% of your desired set point and the main operating pressure control to your desired set point.



Gas burner equiped with high-low-off firing



Night Heating Pressure Control (Optional)

Low firePressure Control

Panel Box for Boilers equiped with high-low-off firing

Operation

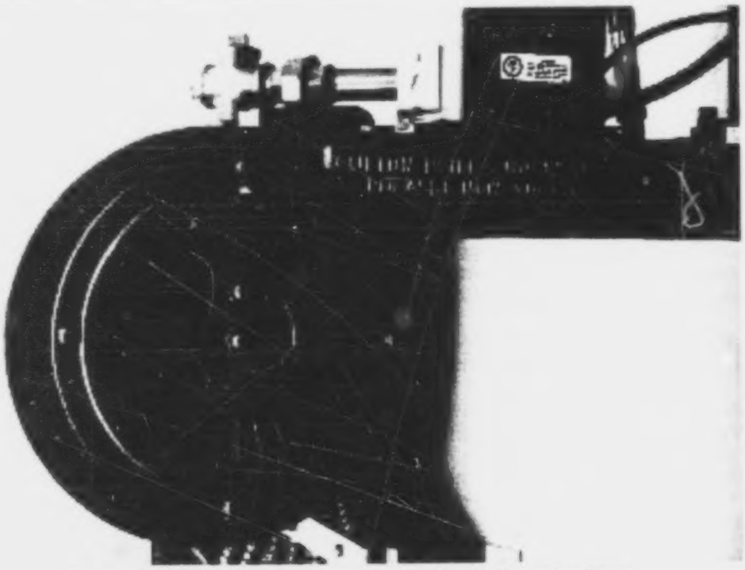
WARNING

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be disconnected.

Primary Air Adjustment for Fulton Gas Fired Steam Boilers

a) The primary air adjustment or main air control is located at the fan housing face. This control is used to supply the burner with excess air needed to facilitate good combustion. Too much or too little air will result in poor combustion. It is important to make sure the lowest level of excess oxygen is present while still maintaining a high level of carbon dioxide and negligible carbon monoxide. Using a CO_2 or O_2 tester it is possible to determine the percent of excess air in the combustion mixture.

b) It is a good policy on a gas fired unit to have between 3.5% and 4% oxygen present in the combustion. This will give you 10.5% to 9.5% carbon dioxide. The carbon monoxide level should always be less than 400 PPM.

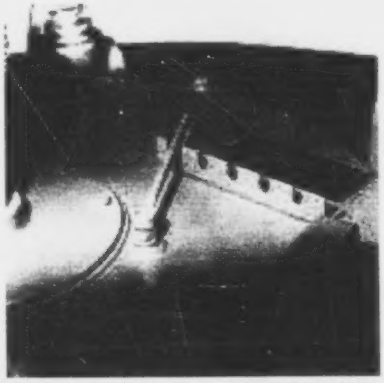


Primary Air Adjustment is located at the fan housing face

Secondary Air Adjustment Procedure for Fulton Gas Fired Steam Boilers

a) The secondary air control adjustment is located on the top, right-hand side of the burner assembly. This damper type air controller is used to introduce air to and through the blast tube of the burner. The purpose of the secondary air adjustment is to proportionately divide the air to the center or outer fire chamber. By moving the damper closed, the air is forced to the outside of the fire chamber with less air going down the blast tube area. By pulling the damper open more air is forced down the blast tube and less on the outside wall of the deflector face and fire chamber.

Secondary Air Adjustment 4-30 HP

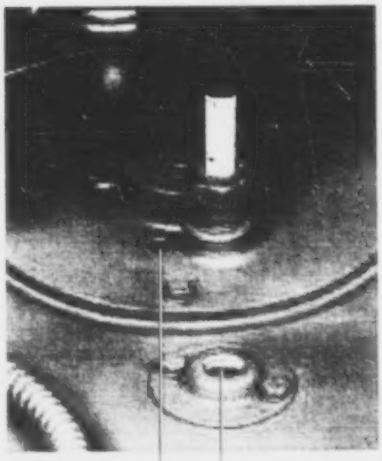


Secondary Air Adjustment 40-60 HP

b) It is important in the combustion process to maintain proper air mixtures between the outer surface and center of the blast tube area. On most boilers the damper is locked in a wide open position. However, if it is necessary to close the damper, care should be taken to close the damper slowly and no more than 1/4 of the distance of the swing of the damper assembly.

c) A visual examination down the blast tube should reveal that no heat, flames or fumes are backing up through the burner plate area. If they are, the secondary damper must be opened up once again. Failure to remove the flame or gases from the blast tube area can cause a backfire as well as cause premature failure of electrodes, flame rods, and other burner components.

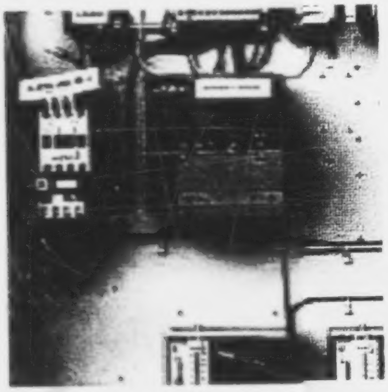
d) A visual inspection down the burner view port should also show the fire completely covering the furnace walls. If the fire is tunneling down or is not to the outside wall of the furnace, the efficiency will drop off. Close the secondary air damper until tunneling stops.



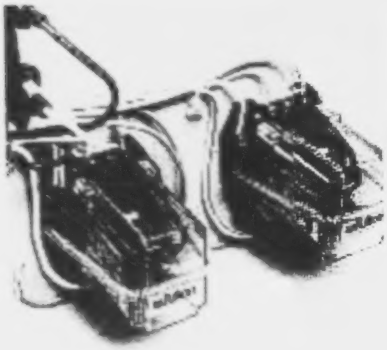
Operation

Boiler Controls

a) Flame safeguard burner control– This is the main control in the panel box. The programmer in conjunction with a sensing device, either a flame rod or an ultra violet scanner,"supervises" the ignition sequence - proves the flame is satisfactory - and finally "monitors" the established flame. Should any fault occur, either during the ignition sequence or during normal running, the programmer will immediately go to "lock-out" and the burner will shut down.



b) Low Water Cut-Off–probe type– Cuts off the unit when water level is too low after a 3 second time delay to avoid nuisance shut downs. As a standard feature, Fulton boilers are equipped with ASME CSD-1 Code controls which include a manual reset feature on the burner low water cut off relay and ASME CSD-1 Code controls also feature an independent second low water cut off relay. Press the low water reset button and the boiler will start.

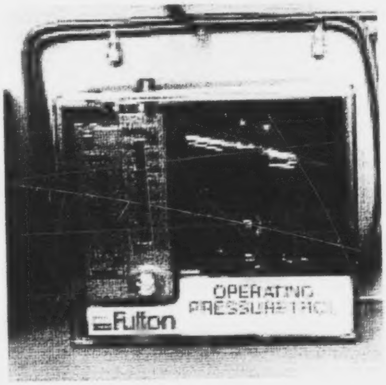


CAUTION

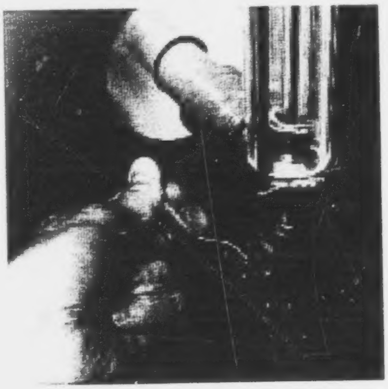
Do not tamper with the safety features of the low water safety cut out.

c) Pressure Relief Valve– limits maximum operating pressure of the boiler.

d) Operating Steam Pressure Control– located in the control panel box and connected to the steam pressure gauge assembly by means of a copper tube. The pressure control regulates the on/off cycle of the burner, shutting the burner off when maximum pressure is reached and switching on when the steam pressure falls below a predetermined level.

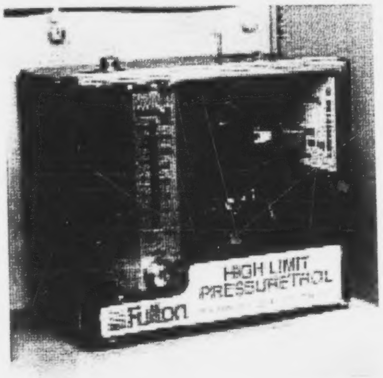


e) Sight Glass Isolation Valves– The brass sight glass isolation valves are equipped with an internal ball check. In the event that a sight glass should break, the ball will seat, preventing the discharge of steam and water. The brass valve stem must be opened fully to enable this feature. If the valve is in any other position than full open, the ball will not seat. For added safety all Fulton boilers are equipped with gauge glass protectors.

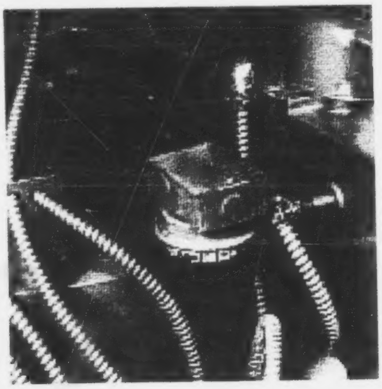


f) High limit pressure control– located in the control panel box and connected to the steam pressure gauge assembly by means of a copper tube. The pressure is usually set 10 to 15 PSI (.703 - 1.054 kg/cm^2) above the operating pressure, but below the maximum pressure of the pressure relief valve. If the pressure exceeds the high limit pressure control setting, the boiler will automatically shut off.

The high limit pressure control must be manually reset by depressing the plunger located on top of the control.



f) Air Pressure Switch– mounted on the burner scroll, this switch is operated by the pressure of air entering the burner through the throat of the scroll. Absence of air, or insufficient pressure, will prevent the switch completing the circuit, thus preventing the burner from operating.



WARNING

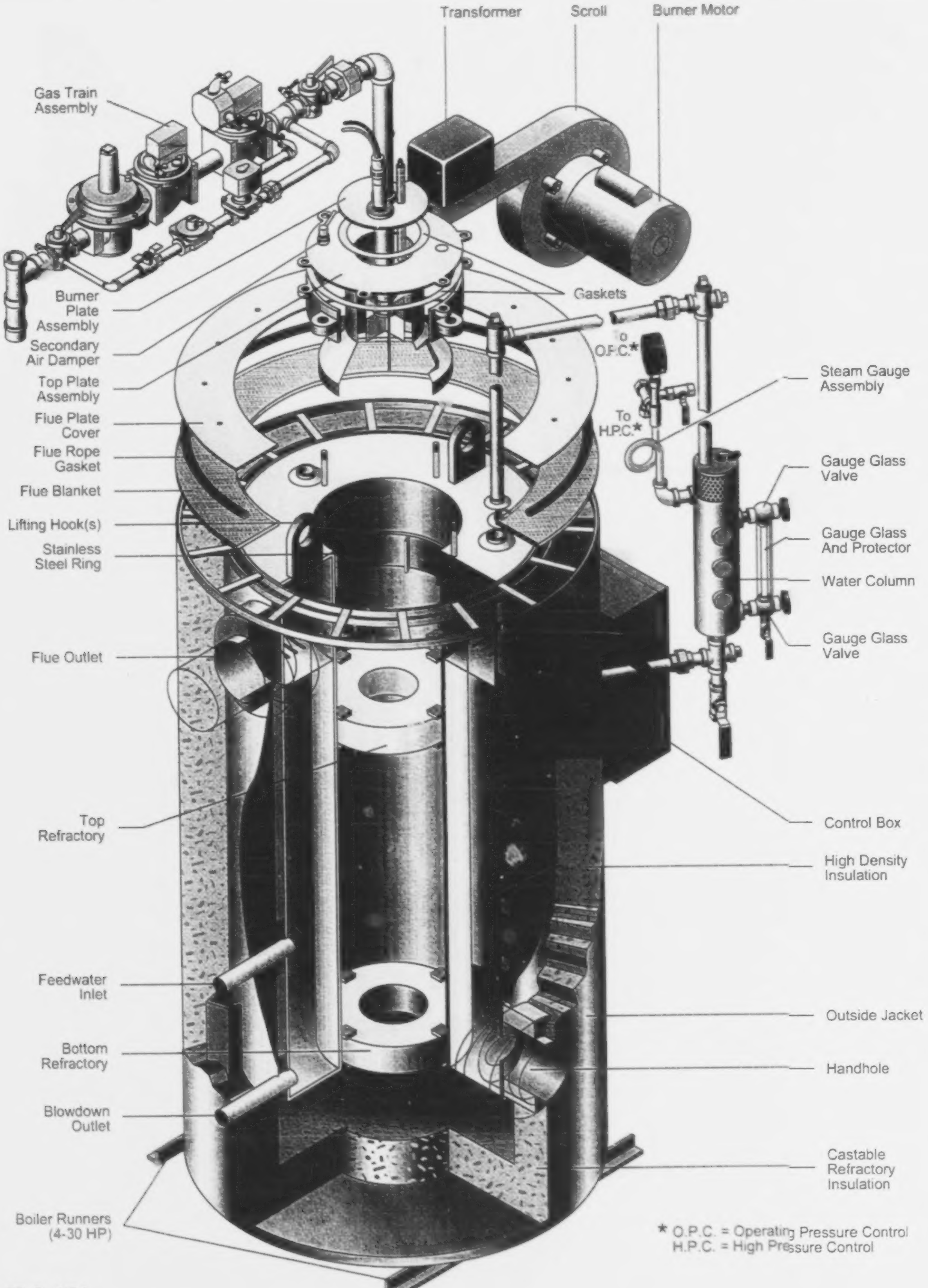
When stopping the boiler for any extensive repairs, shut off main disconnect switches on both the boiler side as well as the feed water side.

NOTE

To ensure that your Fulton Steam Boiler is kept operating safely and efficiently, follow the maintenance procedures set forth in Section 4 of this manual.

Maintenance

4


Transformer
Scroll
Burner Motor
Gas Train Assembly
Burner Plate Assembly
Secondary Air Damper
Top Plate Assembly
Flue Plate Cover
Flue Rope Gasket
Flue Blanket
Lifting Hook(s)
Stainless Steel Ring
Flue Outlet
Top Refractory
Feedwater Inlet
Bottom Refractory
Blowdown Outlet
Boiler Runners (4-30 HP)
Gaskets
To O.P.C.*
To H.P.C.*
Steam Gauge Assembly
Gauge Glass Valve
Gauge Glass And Protector
Water Column
Gauge Glass Valve
Control Box
High Density Insulation
Outside Jacket
Handhole
Castable Refractory Insulation

* O.P.C. = Operating Pressure Control
H.P.C. = High Pressure Control

Maintenance

NOTE

To ensure the continued safety and efficiency of the boiler, the schedule of maintenance outlined in this section should be adhered to.

WARNING

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be disconnected.

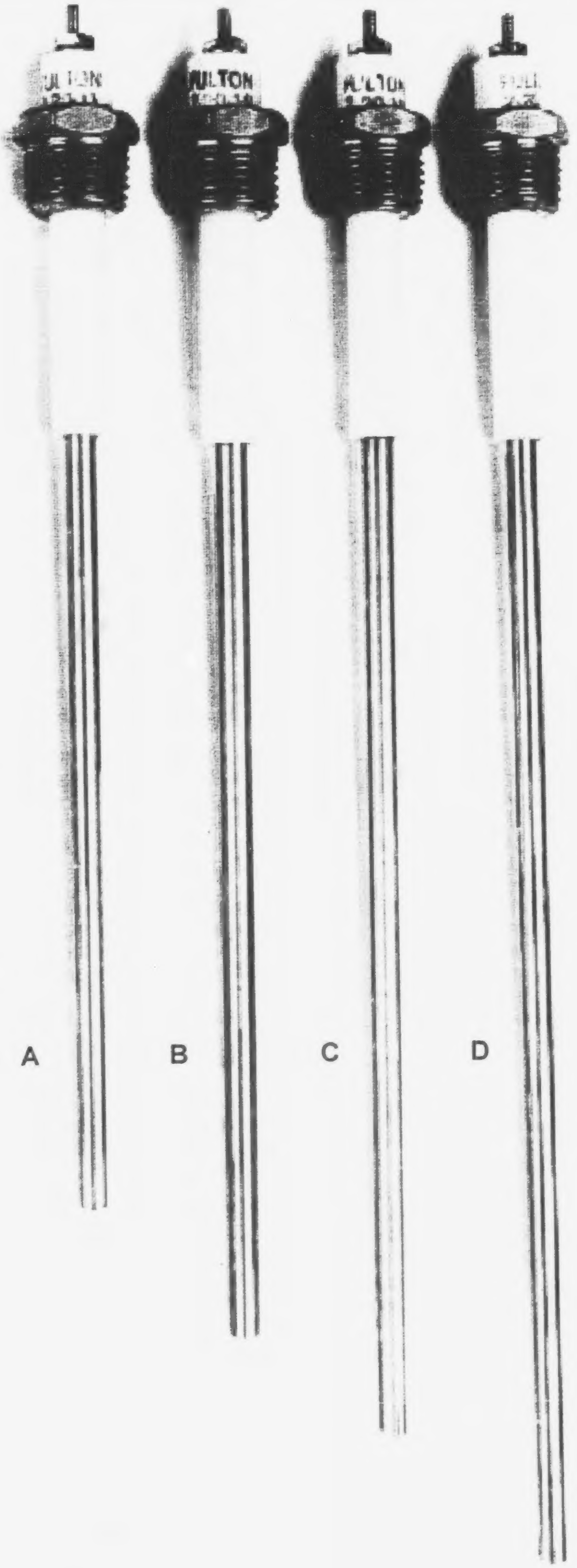
Procedure for Cleaning Water Probes

Clean probe on top of boiler shell and probes in water column. Make sure there is no pressure on the boiler during the removal of the probes. Remove one probe (using a 7/8" socket), clean with very fine emory cloth and replace it before removing another to assure no probe mix-ups that would change the control functions.

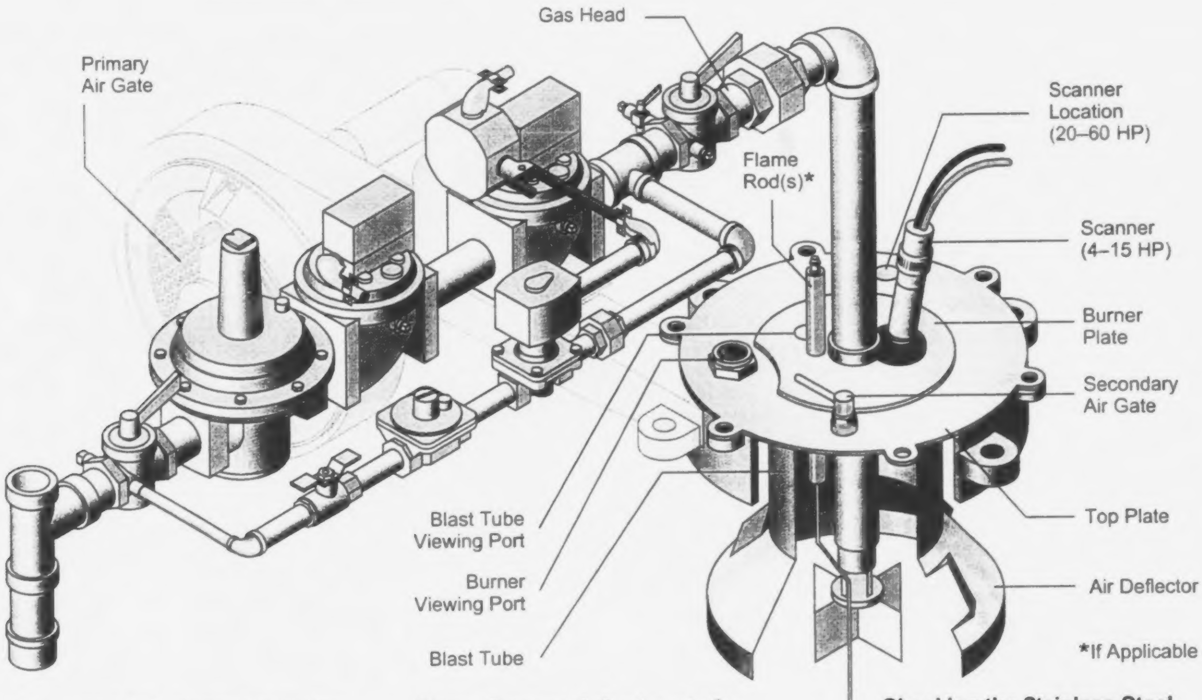
For replacement purposes, installed probe lengths are indicated in the chart below. For a universally adaptable plug and probe which can be cut to length in the field to fit all boilers, order Part No. 2-20-017.

*A = 7-1/4" – 184 mm
*B = 9-1/4" – 235 mm
*C = 11-1/4" – 286 mm
D = 17-1/8" – 435 mm

*For 4 HP boilers only, water column probes are 2" shorter.



Maintenance



Flame Rod Adjustment for Fulton Gas Fired Steam Boilers

a) The flame rod adjustment is made by loosening the lock nut and turning the porcelain portion of the flame rod clockwise or counter clockwise. Whenever a flame rod is moved, care should be taken to ensure that the flame rod does not ground out by touching the metal surface of the blast tube assembly. A keyboard display module can be used to determine proper signal response. It is necessary to establish pilot so that the main gas valve will engage. The main flame should be adjusted to an acceptable flame signal to ensure continued performance. A poor signal will result in the boiler flame programmer going off on safety.

b) A single flame rod is used on 4-15 HP Fulton Boilers, and two flame rods on 20 and 30 HP. If the boiler has two flame rods, adjust the flame rod in the burner plate first, with the outside one disconnected. After a good pilot signal is established on the inside flame rod, then the outside flame rod can be hooked up and the signal adjusted for proper responses.

c) If a signal is erratic after adjusting the flame rod, the main and secondary air supplies may need adjusting. If a flame rod is cracked or broken, the porcelain will have to be replaced to get a proper signal.

Flame Scanner Adjustments for Fulton Gas Fired Steam Boilers

a) Flame scanner adjustments are made with the detectors installed and the burner running. It is essential to obtain optimum flame signal detection for safe and continual operation of the control relay.

b) If a scanner is inoperable, it may prove the detector is working and only an adjustment to the pilot flame is needed to improve the signal.

c) If the scanner is found to be defective, replace.

NOTE:

The scanner is located on the outside edge of the burner top plate for 20-60 HP.

d) For the RM7800 Series use a keyboard display module or volt meter,the flame safeguard will require a 1.25 VDC signal to pull in the main flame. Then a maximum signal should be obtained on main flame (5.0 VDC).

e) Adjustments to establish a good signal may include the following items:

1) Primary and secondary air adjustments.

2) Increasing the pilot gas through the pilot gas regulator.

Checking the Stainless Steel Combustion Ring on Fulton Gas Fired Steam Boilers

a) The stainless steel combustion ring in Fulton gas fired boilers (50-60 HP only) are designed to bring quick and effective flame transfer to the fire wall. The ring should fit securely and tight against the furnace wall for best results.

b) The ring should be inspected for distortion in the event of poor combustion which could result in flame failures.

Stainless Steel Combustion Ring

Maintenance

Furnace Refractory Replacement Procedure

a) Remove the burner plate and top plate assembly up and out of the scroll assembly.

b) Remove the stainless steel combustion ring from the furnace (50 and 60 HP only).

c) Remove the clean-out plugs from the bottom sides of the boiler. 4-15 HP boilers have one clean out plug located at the bottom of the boiler directly below the panel box. 20-60 HP boilers have one clean out plug located at the bottom of the boiler to the right side of the panel box. 10-30 HP Energypak Boilers have one clean out to the right of the lower right side hand hole and one clean out to the right of the rear bottom blow down.

d) Break off the top holding clips that were used to keep the refractory in position during shipping. The 4-50 HP boilers also have holding clips beneath the top refractory. There is no need to cut the holding clips located beneath the top refractory as the refractory may be rotated to avoid these clips during installation of the lower refractory. The 60- HP boiler has welded flat bars beneath the top refractory. These bars will have to be cut to change the lower refractory. Rewelding of the bars will be required prior to installation of the top refractory. For the lower refractory you will also need to break off the top holding clips that were used to keep the refractory in position during shipment.

e) Break up the top and/or bottom refractories and remove the pieces from the boiler through the clean-out plugs.

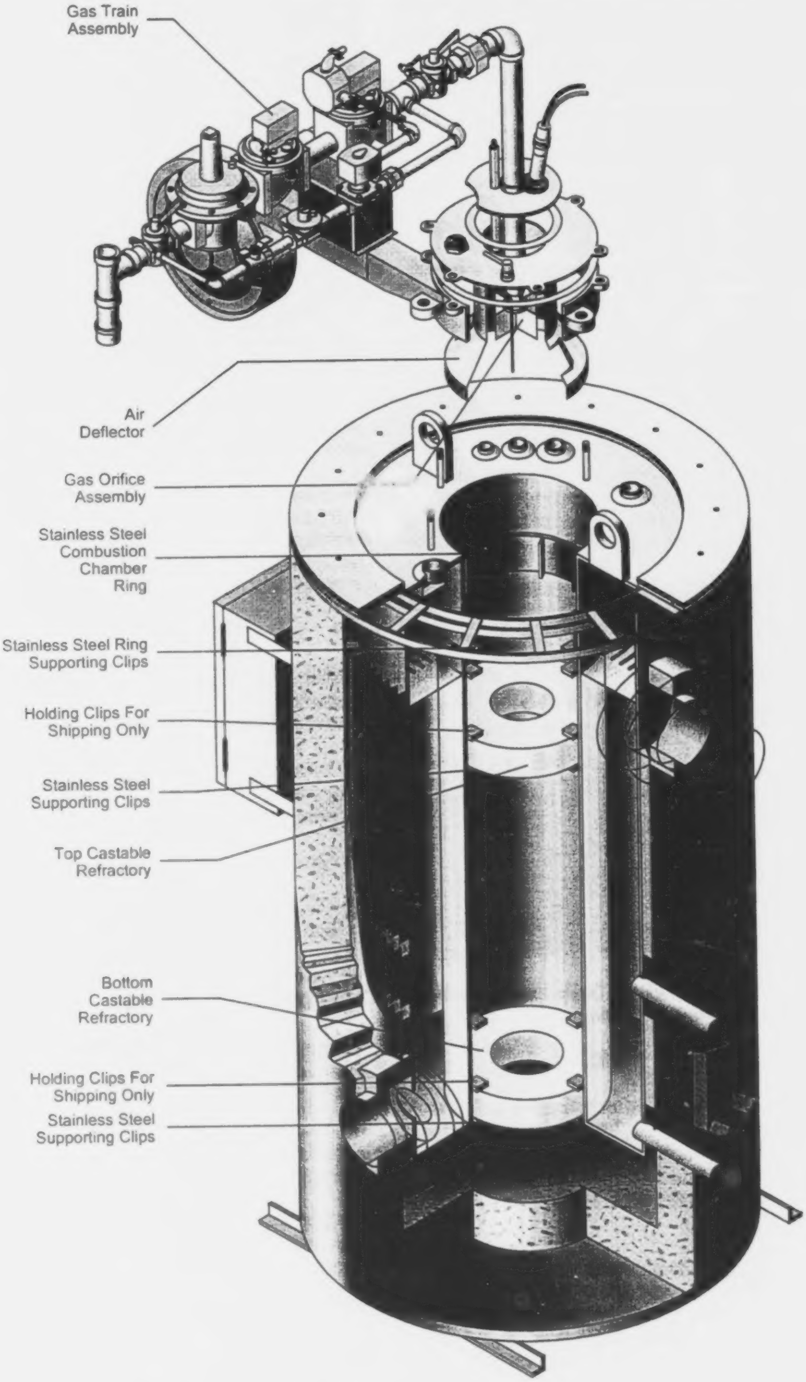
NOTE

If only the top refractory is to be changed, the bottom refractory need not be broken.

f) Round and bevel the outer edges of the new refractories.

g) The bottom refractory has the largest hole, while the top refractory has the smallest.

h) Lower the bottom refractory down the furnace with wire fastened around the refractory in three positions. When the refractory is close to position, it can be tipped by maneuvering the wire to drop it flat on the holding clips. If the refractory will not tip, it may have to be removed and again rounded and beveled.



Gas Train Assembly
Air Deflector
Gas Orifice Assembly
Stainless Steel Combustion Chamber Ring
Stainless Steel Ring Supporting Clips
Holding Clips For Shipping Only
Stainless Steel Supporting Clips
Top Castable Refractory
Bottom Castable Refractory
Holding Clips For Shipping Only
Stainless Steel Supporting Clips

i) Install the top refractory in the same manner as the bottom refractory. When installed the outer edges must be sealed with insulcrete - a castable refractory mix available from the Fulton factory.

It is not necessary to reinstall the shipping clips.

j) Install the stainless steel combustion ring, (50-and 60 HP only) burner assembly, and clean out plug.

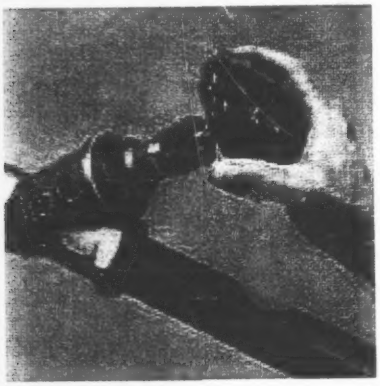
k) normal operation can be resumed immediately.

Maintenance

Recommended Daily Maintenance Schedule

a) The following procedures should be carried out daily. They are designed to prevent the build up of scale, silt, or sludge in the bottom of the boiler and in the pipes leading to the water gauge. In addition to these procedures, the advice of a water treatment supplier should be sought and followed. An ASME Section VIII blow off receptacle must be provided for the appropriate pressure.

b) Blow down the boiler each morning by starting the boiler and generating not more than 10 PSI (.703 kg/cm^2) of steam. Turn on tap water to blow-off separator, then open the boiler blow off valve for approximately 10 seconds, then close the valve. Shut off tap water to blow-off separator.

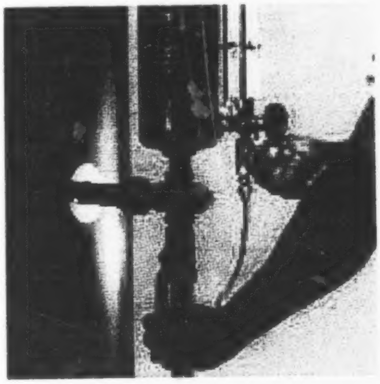


Blow Down Boiler Daily. Shown is the blow down "Y" valve.

NOTE

If the boiler is being operated automatically on a time clock, the blow off operation may be done once during the working day and once at the end of the day when at 10 PSIG or less.

c) Blow down water column each morning when boiler is at 10 PSI (.703 kg/cm^2) by opening the water column and the water gauge blow off valves for approximately 5 seconds, then close the valves.



Blow down water column each morning by opening the water column and the water gauge blow-off valves.

d) If the feed water is being treated by compounds, make sure that this treatment is carried out carefully and according to the manufacturer's instructions.

NOTE

Fulton recommends that the feedwater treatment should be added between the pump and the boiler.

e) When first starting the boiler each day, make sure ignition and burner are working properly.

f) Check water level in sight glass.

g) Check to be sure feed water pump is working.

h) For float type water level control, blow-down float chamber.

Recommended Weekly Maintenance Schedule

a) Check that the low water cut-off relay is operating correctly in the following manner:

1) Make sure that the boiler is cool with little or no pressure showing on the steam pressure gauge.

2) With the burner operating, open the boiler blow off valve. When the water drops below the required level (note the level in the water gauge glass) the burner should shut off; this is when the water level falls below the low water electrode in the water column assembly and/or the boiler shell. Manual reset of the low water relay is required.

Recommended Monthly Maintenance Schedule

WARNING

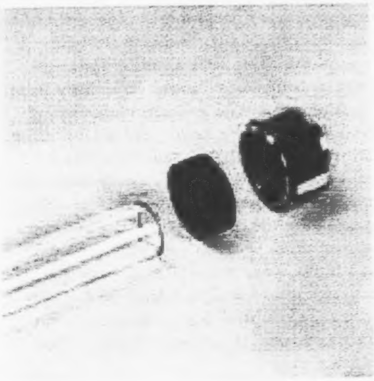
Make sure main power switch is off before starting work.

a) Clean the water gauge glass.

CAUTION

Do not clean the gauge or gauge glass while pressurized or in operation.

1) Clean the water gauge glass using a commercial non-abrasive glass cleaner. Use diluted acids such as hydrochloric (muriatic) acid when regular cleaners do not seem to work. Do not use wire brushes or any other abrasive materials which could scratch the glass. If any leakage is evident, replace the gaskets.



Clean Glass; Replace Gaskets If Leaking

2) Always replace the high impact plastic gauge glass protector which is standard on all Fulton Boilers.

b) Clean water pump strainers.

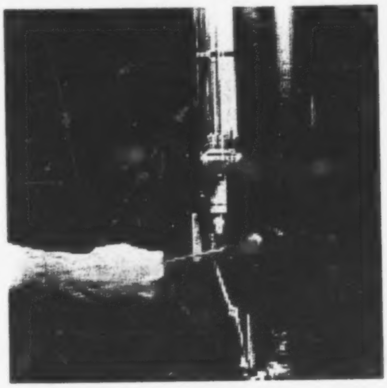
c) Check scanner or flame rod and ignition electrodes.

d) Check starter contacts. Burned or pitted contacts should be replaced. Do not use sand paper or file to clean.

e) Clean water traps and strainers in fuel lines.

f) Check operation of all steam traps on condensate return system.

g) Remove brass pipe plug at the cross connection below water column and clean nipple into boiler. Boiler must be cold and water level below pipe.



Remove plug at cross section; clean nipple to boiler.

Recommended Semi-Annual Maintenance Schedule

a) Cleaning the gas burner assembly

1) Disconnect the gas head from the burner by disconnecting the union. Remove the burner plate screws. For 4-15 HP boilers with scanner, disconnect scanner from burner plate. Withdraw the burner assembly and clean the flame rod and ignition electrode.

2) Check that the settings of the flame rod, if applicable, and ignition electrode correspond to those in the illustration below.

3) Reassemble the burner assembly and check the flame rod setting or scanner setting.

4) Check the combustion efficiency of the burner and adjust if necessary.

5) Clean probe on top of boiler shell and probes in water column. There must be no pressure on the boiler during the removal of the probes.

6) Check refractories for soot or breakage and inspect the stainless steel ring (50 and 60 HP only).

7) With the boiler under no more than 15 PSI pressure, check that the steam safety valve is operating by lifting the lever.

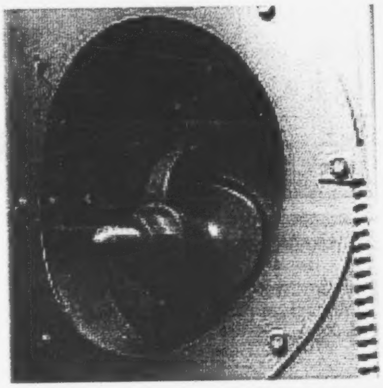
b) Drain condensate tank and clean tank by flushing with hose. Check float valve operation.

c) Check electrical controls and motors for correct operation.

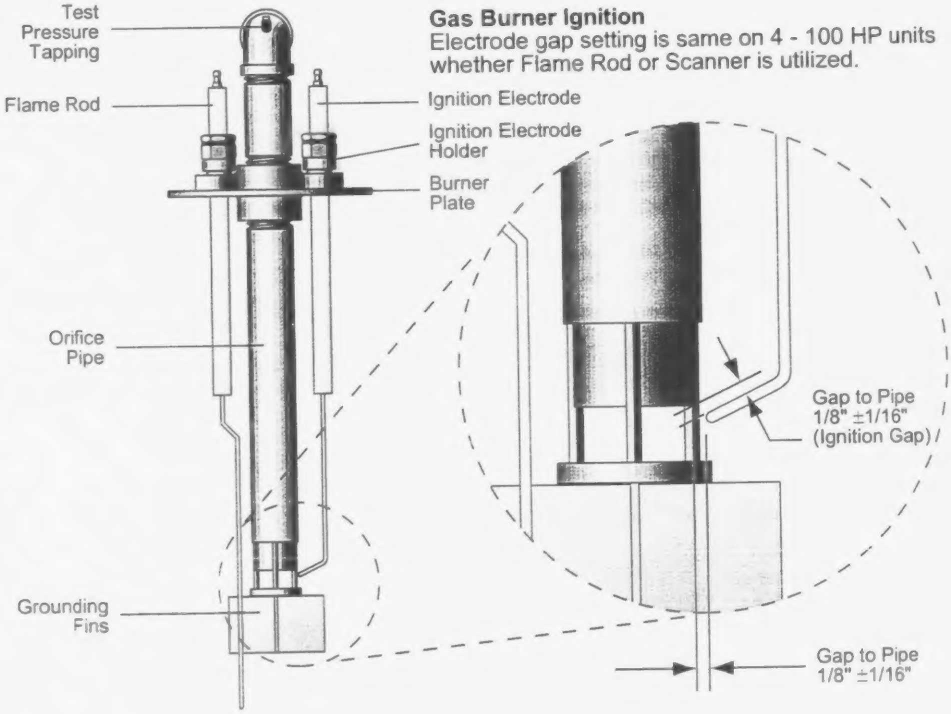
d) Check water pump for correct operation.

e) Shut off the boiler completely and drain.

f) Remove the hand holes and inspect the interior of the vessel for scale or sludge deposits. The amount of deposits will indicate the efficiency of the water treatment being used. The frequency of the inspection will depend on the condition of the water side of the boiler.



Inspect hand holes for scale or sludge buildup.



Gas Burner Ignition
Electrode gap setting is same on 4 - 100 HP units whether Flame Rod or Scanner is utilized.

Maintenance

g) Replace hand hole gaskets using the following procedure:

1) Remove the hand hole assembly using a 1-1/4" tee handle wrench or 1-1/4" 1/2" drive socket wrench.

Removing hand hole assembly with a Tee Handle Wrench

2) Remove the old gasket and thoroughly clean the surface on the boiler and the plate.

3) Fit the hand hole assembly as follows:

a) Place the gasket on the hand hole plate and ensure that it is seating correctly. **Do not use any grease, lubricant, or adhesive.**

b) Position the plate in the boiler. Set the yoke and tighten the securing nut sufficiently enough to provide a snug fit. Verify the position of the plate in the boiler, then make it hand tight and then snug with wrench about 1/4 turn. Do not compress excessively.

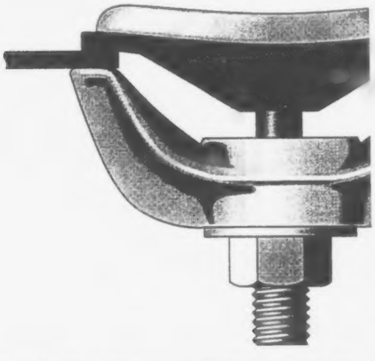


Illustration shows correct pressure on gasket.

c) If the gasket leaks while pressure is being built up, tighten only enough to stop leakage. Never tighten more than necessary to prevent leakage. Excessive tightening may shorten the life of the gasket.

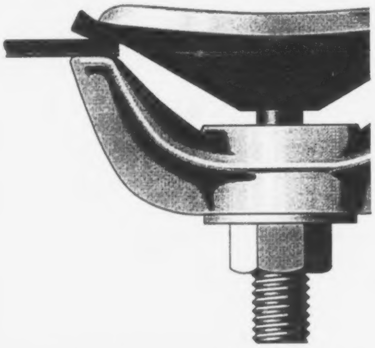


Illustration shows over compressed gasket.

d) Refill the boiler with fresh water.

NOTE

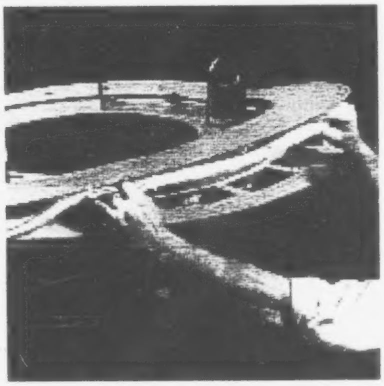
After a new Fulton Boiler has been in operation for several months, pieces of burned metal will be found in the space at the bottom of the boiler. These pieces of metal are the remains of a light gauge metal form which was used during manufacture for forming the boiler insulation. This is a normal condition and does not affect the efficiency or the life of the boiler in any way.

Recommended Annual Maintenance Schedule

a) Have combustion (CO_2, O_2, CO) and input checked by responsible personnel.

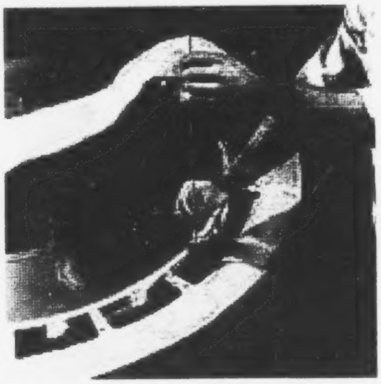
b) Dirty flues can cause air flow restrictions resulting in poor combustion and loss of efficiency.
Clean flues as follows:

1) Remove the burner and flue cover plate.



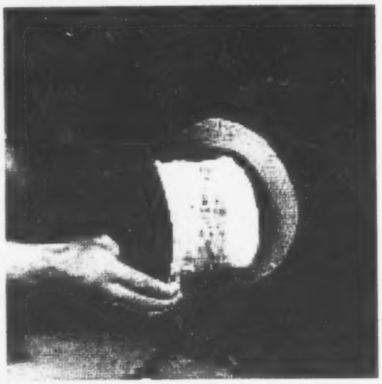
Remove burner and flue cover plate

2) Wire brush flue passages.



Wire brushing the flue passages.

3) Remove clean out plugs at lowest part of unit and clean the bottom of combustion chamber.



Removing clean out plugs.

4) Remove all soot from the top, and from the clean out plugs at the bottom with a vacuum cleaner.

5) Replace clean out plugs carefully so as not to damage insulation and replace burner and flue cover plates.

c) Flush boiler out if necessary. See Section 2 for proper procedure for "Cleaning the Pressure Vessel."

d) Provide annual inspection by a qualified ASME Boiler inspector.

Maintenance

Troubleshooting

a) The following trouble shooting guide will assist in the diagnosis and the correction of minor field problems. It contains instructions and information necessary to locate and isolate possible troubles which occur during normal operation. It should be used in conjunction with the unit wiring diagram and the component literature provided in Section 7 of this manual.

b) The following lists cover the most common troubles that may occur on the Fulton gas fired boilers. Refer to left hand column of the chart to locate the problem. Determine which cause, listed in the center column, that represents the problem by performing the corrective action as listed in the right hand column titled "REMEDY".

Troubleshooting Gas-Fired Boilers

Problem	Cause	Remedy
Ignition Failure	1. Power Supply	Check fuse or circuit breaker. Reset or replace, as necessary.
	2. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustment. Readjust if necessary. Check for cracks in porcelain. If found,replace.
	3. Transformer	Check voltage between transformer leads at terminal block to be sure transformer is being powered.
	4. Flame Safeguard Control	Check voltage between ignition terminal and neutral. Check must be made before control locks out on safety. If no power, replace control.
	5. Faulty Air Switch	Check for bad air switch by jumpering the two air switch leads at the terminal block. If the boiler starts and runs with these terminals jumpered, the air switch should be replaced.
	6. Gas Valve Sticking (Pilot)	Check for dirt in valve or orifice and clean if necessary. Check for faulty actuator or valve and replace if necessary.
	7. Gas Supply*	Check for gas pressure and for intermittent supply problems. Gas pressure for natural gas should be 3-1/2" W.C. plus fan pressure at the elbow to the burner and 7" to 11" W.C. at the head of the train.
	8. Loose wire connection	Check connections to all components.
Flame Failure	1. Power Supply	Check fuse or circuit breaker. Reset or replace, as necessary.
	2. Gas Supply*	Check for gas pressure and for intermittent supply problems. Gas pressure for natural gas should be 3-1/2" W.C. plus fan pressure at the elbow to the burner and 7" to 11" W.C. at the head of the train.
	3. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustment. Readjust if necessary. Check for cracks in porcelain; if found, replace.
	4. Primary Air Adjustment	Check air adjustment. Air may be blowing flame away from flame rod.

* For natural gas fired boilers. Refer to the test fire sheet for all other fuels.

Maintenance

Problem	Cause	Remedy
Flame Failure	5. Flame Rod Adjustment or UV Scanner	Check flame rod for carbon buildup and clean if necessary. Check flame rod adjustment via a display module. Flame signal should be 5 VDC. Check for cracks in porcelain. If found, replace. Check for dirt on flame scanner and clean. Check for proper location of detector.
	6. Flame Safeguard Control	Check voltage at terminal leading to main gas valve. If no power, replace the control.
	7. Loose wire at fuel valve circuit	Tighten wiring connections.
	8. Contact open on air safety switch	Adjust to proper setting.
	9. Scanner wiring reversed at panel box.	Change to correct terminals.
Burner Cut-Off	1. Power Supply	Check fuse or circuit; reset or replace, as necessary.
	2. Gas Supply	Check to be sure main gas cock is not closed. Check coil in gas valve with OHM meter. Replace if faulty. Check gas regulator setting and readjust as necessary. Check inlet gas pressure and increase or decrease as necessary.
	3. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustment Readjust if necessary. Check for cracks in porcelain; if found replace.
	4. Flame Rod Adjustment or UV Scanner	Check flame rod for carbon buildup and clean if necessary. Check flame rod adjustment via a display module. Flame signal should be 5 VDC. Check for cracks in porcelain. If found, replace. Check for dirt on flame scanner and clean. Check for proper location of detector.
	5. Air Switch	Check for bad air switch by jumpering the two air switch leads at the terminal block. If the boiler starts and runs with these terminals jumpered, the air switch should be replaced.
	6. Gas Valve Sticking (Pilot)	Check for dirt in valve or orifice and clean if necessary. Check for faulty actuator or valve and replace if necessary.
	7. Weak Ampl;ifier	Replace.
	8. Weak Pilot	Adjust to larger pilot by adjusting pilot gas pressure regulator.
	9. Faulty Liquid Level Control	Check to see if there is power to terminal number 10 when the sight glass shows the proper water level. If there is no power at this terminal, the control is bad and must be replaced.
	10. Dirty or defective UV Scanner.	Clean or replace.

Maintenance

Problem	Cause	Remedy
Poor Combustion	1. Refractories	Check refractories to see if they are plugged with soot or broken in pieces. Clean or replace as necessary.
	2. S.S. Ring	Check to be sure ring is present and fits tight against the furnace wall (50-100 HP).
	3. Primary Air Adjustment	Check air adjustment. Air/fuel mixture may be off. Open primary air so fire is to outside wall of furnace.
	4. Secondary Air Adjustment	Check main air adjustment to see if it is loosened up. Adjust as necessary and tighten plate in position. Check CO_2 and O_2 levels.
	5. Draft	Check draft with a gauge. Draft should be a -.02 " to -.04" W.C. with burner off or -.04" to -.06" when operating. May need to install a barometric damper.
	6. Dirty Flue	Check flue for carbon buildup or blockage. Clean flue passages with brush.
	7. Negative Room Pressure	Make sure no exhaust fans are running in the boiler room.
Burner back fires	1. Refractories	Check refractories to see if they are plugged with soot or broken in pieces. Replace as necessary.
	2. Ignition Electrodes	Check electrodes for carbon buildup and clean if necessary. Check for proper adjustment Readjust if necessary. Check for cracks in porcelain; if found replace.
	3. Flame rode adjustment or UV Scanner	Check flame rod for carbon buildup and clean if necessary. Check flame rod adjustment via a display module. Flame signal should be 5 VDC. Check for cracks in porcelain. If found, replace. Check for dirt on flame scanner and clean. Check for proper location of detector.
	5. Draft	Check draft with a gauge. Draft should be a -.02 " to -.04" W.C. with burner off or -.04" to -.06" when operating. May need to install a barometric damper.
	6. Negative Room Pressure	Make sure no exhaust fans are running in the boiler room.
Boiler will not maintain pressure	1. Gas Supply	Check gas pressure coming into gas train. If low, contact gas company. Should be 7" to 11" W.C. Check coil in gas valve with AMP meter. Replace if bad. Check gas regulator setting and readjust as necessary.
	2. Dirty Flue	Check flue for carbon buildup or blockage. Clean flue passages with brush.
	3. Pressuretrol	Disconnect all power to the controller. Disconnect the wires from the controller. Put an OHM meter between the switch terminals. Lower the set point of the controller. Switch should make. Raise the set point and recheck with OHM meter. Switch should break. If the controller operates improperly, replace it.

Maintenance

Problem	Cause	Remedy
Boiler will not maintain pressure	4. Scale Built up in boiler	Refer to Section 2 "Pressure Vessel Cleaning".
	5. Refractories	Check refractories to see if they are cracked or broken in pieces. Replace as necessary.
	6. Steam traps blowing through.	Check traps to see if they are clean or replace as necessary.
	7. Boiler size.	Boiler may be undersized.
Boiler is Surging	1. Steam traps blowing through	Check traps to see if they are clean or replace as necessary.
	2. Perc (cleaning solvent in boiler)	Clean boiler with washing soda per instruction manual.
	3. Scale build-up or lime deposits.	Call water treatment professional and consult factory.
	4. Too much compound in system (water treatment)	Dump return tank and flush system. Have water tested by water treatment company.
	5. Too much water softener (high PH)	Have water tested by water treatment company.
	6. Too much of a load	Check total equipment horsepower required against horsepower of boiler being used. Decrease amount of equipment being used at one time.
	7. Boiler new (not cleaned).	Clean per instructions in instruction manual.
Boiler Rumbles and Pulsates	1. Draft problem	Check draft with a gauge. Draft should be a -.02 " to -.04" W.C. with burner off or -.04" to -.06" W.C. when operating. May need to install a barometric damper.
	2. Too much primary air	(See primary air adjustment)
Boiler pushing water with the steam	1. Steam Traps	Check traps. Clean or replace as necessary.
	2. Too much boiler compound	Dump return tank and flush system . Have water tested by water treatment company.
Pump will not cut off	1. Dirty Probes	Clean or replace as necessary.
	2. Relay failed	Make sure relay is plugged in tightly. If so, replace water level relay.
	3. Ground Connection	Check for tightness and clean.

Maintenance

Problem	Cause	Remedy
Pump runs but does not put water into boiler	1. Vapor locking of pump.	Allow system to cool down, check steam traps and check to be sure return lines are not insulated. Check return tank temp. If it is above 180 deg. F, (82 deg. C) vapor locking of pump will occur. Inspect check valves. Clean and replace as needed. Replace pump with multistage centrifugal good for 250 degrees F (121 deg.C).
	2. Impeller Adjustment	Check for impeller wear and adjust per component information in instruction manual (Burks only).
	3. Back pressure on pump	Need to install repair kit on pump.
	4. Plugged feed water nipple	Check and clean or replace as necessary.
Water pump will not come on at times.	1. Scale on probes.	Check and clean or replace as necessary.
	2. Bad Pump Contactor	Check to see if contactor is being powered. Check to see if contactor coil is pulling in. Replace if necessary.
	3. Bad Pump Motor	Check the incoming power to the pump to be sure it is receiving power. If power is present but motor does not run, replace it.
Low Fuel pressure	1. Gas pressure regulator	Check and replace.
Boiler Flooding	1. Pump does not shut off	Dirty Probes. Clean or replace as necessary.
	2. Relay failed	Make sure relay is plugged in tightly. If so, replace water level relay.
	3. Ground Connection	Check for tightness and clean.
	4. Vacuum created with boiler off.	As the boiler cools off, it pulls water from the system piping. To prevent this, add a 1/4" check valve on the steam gauge assembly piping, which closes under pressure and opens under vacuum.

5

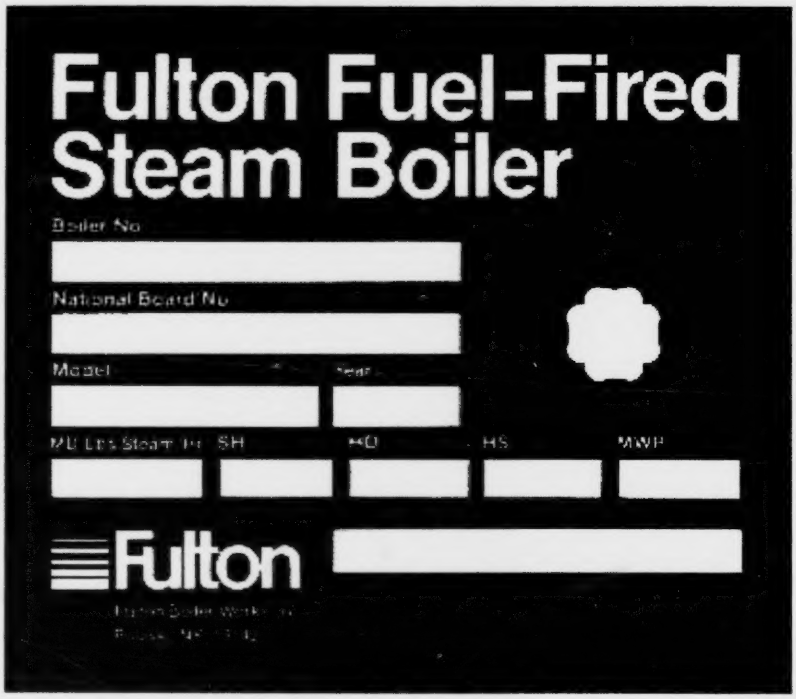
Parts

Spare Parts

a) It is important that the correct replacement part is fitted to your Fulton Gas Fired Steam Boiler.

b) When ordering replacement or spare parts, make sure that the full information given in the Parts List is supplied, together with the following details as shown on your boiler identification plate:

1. Boiler Number
2. Boiler Type
3. Electrical Specifications


Fulton Fuel-Fired Steam Boiler
Boiler No
National Board No
Model
Year
MB Lbs Steam Hr
SH
HD
HS
MWP
Fulton
Fulton Boiler Works, Inc.

Note:

The policy of Fulton Boiler Works, Inc. is one of continuous improvement, and therefore, we reserve the right to change prices, specifications, and equipment without notice.

Parts

Replacement Parts Listing (available from authorized Fulton Representative)

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
5-60-100	Instruction Manual, Fuel-Fired	2	0.91
5-60-165	Certification Papers		
5-60-164	Boiler Documentation for Export Boilers		
	Boiler Shell Parts		
5-12-004	Furnace Refractory 8" OD x 2" ID (9.5 HP Top)	10	4.55
5-12-005	Furnace Refractory 8" OD x 21/2" ID (4 HP Gas Top - Old Style)	10	4.55
5-12-006	Furnace Refractory 8" OD x 3" ID (9.5 HP Bottom)	10	4.55
5-12-007	Furnace Refractory 10" OD x 3" ID (4-10 HP Top)	18	8.18
5-12-008	Furnace Refractory 10" OD x 31/2" ID (15 HP Top)	18	8.18
5-12-009	Furnace Refractory 10" OD x 5" ID (4-15 HP Bottom)	18	8.18
5-12-010	Furnace Refractory 15" OD x 51/2" ID (20 HP Top)	35	15.91
5-12-011	Furnace Refractory 15" OD x 6" ID (30 HP Top)	35	15.91
5-12-012	Furnace Refractory 15" OD x 7" ID (20 & 30 HP Bottom)	35	15.91
5-12-015	Furnace Refractory 24" OD x 8" ID (40 - 60 HP Top)	125	56.82
5-12-016	Furnace Refractory 24" OD X 10" ID (40- 60 HP Bottom)	125	56.82
5-12-017	Furnace Refractory 30" OD x 91/2" ID (80 HP Top)	225	102.27
2-12-000	Furnace Cement- 2 lb. can	2	0.91
2-12-001	Furnace Cement - 8 lb. can	8	3.64
2-12-002	Furnace Cement - 15 lb. can	15	6.82
5-10-353	Flue Cover Ring - 4 & 6 & 9.5 HP	19	8.64
5-10-354	Flue Cover Ring -10 HP	20	9.09
5-10-355	Flue Cover Ring - 15 HP	20.5	9.32
5-10-357	Flue Cover Ring - 20 HP	21	9.55
5-10-359	Flue Cover Ring - 30 HP	25	11.36
5-10-360	Flue Cover Ring - 40-60 HP	40	18.18
5-12-001	Bottom Cleanout Access Plate with Plug 4-30 HP	10	4.55
5-12-002	Bottom Cleanout Access Plate with Plug 40-60 HP	20	9.09
5-12-003	Square Cleanout Plug (Not for Series E)	15	6.82
2-12-064	Flexitalic (HHG) Extra Heavy High Pressure	0.5	0.23
2-12-088	Blue Max HHG	0.05	0.02
5-10-800	Handhole Welding Patch 4-60 HP	1.1	0.5
2-12-004	Handhole Gasket 4-60 HP	0.05	0.02
2-11-105	HandholeYoke	1.5	0.68
2-11-100	3 x 4 Handhole Cover 4-10 HP (White)	2	0.91
2-11-101	3 x 4 Handhole Cover 15 HP (Red) .	2	0.91
2-11-102	3 x 4 Handhole Cover 20 HP (Green)	2	0.91
2-11-103	3 x 4 Handhole Cover 30 HP (Yellow)	2	0.91
2-11-104	3 x 4 Handhole Cover 40-100 HP (Blue)	2	0.91
4-11-010	10 HP Handhole Assembly (White)	7	3.18
4-11-012	15 HP Handhole Assembly (Red)	7	3.18
4-11-014	20 HP Handhole Assembly (Green)	7	3.18
4-11-016	30 HP Handhole Assembly (Yellow)	7	3.18
4-11-018	40 -60 HP Handhole Assembly (Blue)	7	3.18
2-12-504	Blanket Insulation (Sq. ft.)	0.5	0.23
5-21-300	Steel Jacket 4 HP - No Holes Cut	80	36.36
5-21-301	Steel Jacket 6 HP - No Holes Cut	80	36.36

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
5-21-302	Steel Jacket 10 HP - No Holes Cut	100	45.45
5-21-303	Steel Jacket 15 HP - No Holes Cut	115	52.27
5-21-304	Steel Jacket 20 HP - No Holes Cut	125	56.82
5-21-305	Steel Jacket 30 HP - No Holes Cut	125	56.82
5-21-306	Steel Jacket 40-60 HP - No Holes Cut	125	56.82
5-21-5064	Bottom Handhole Funnel 4 & 6 HP	6.5	2.95
5-21-5066	Bottom Handhole Funnel 10 HP	6.5	2.95
5-21-5068	Bottom Handhole Funnel 15 HP	6.5	2.95
5-21-5070	Bottom Handhole Funnel 20 HP	6.5	2.95
5-21-5072	Bottom Handhole Funnel 30 HP	6.5	2.95
5-21-5074	Bottom Handhole Funnel 40 & 60 HP	6.5	2.95
5-21-5063	Top Handhole Funnel 4 & 6 HP	6.5	2.95
5-21-5065	Top Handhole Funnel 10 HP	6.5	2.95
5-21-5067	Top Handhole Funnel 15 HP	6.5	2.95
5-21-5069	Top Handhole Funnel 20 HP	6.5	2.95
5-21-5071	Top Handhole Funnel 30 HP	6.5	2.95
5-21-5073	Top Handhole Funnel 40 - 60 HP	6.5	2.95
123	Bottom Funnel Repair Kits 4-15 HP	9.5	4.32
123	Bottom Funnel Repair Kits 20-30 HP	9.5	4.32
123	Bottom Funnel Repair Kits 40-60 HP	9.5	4.32
123	Top Funnel Repair Kits 4-15 HP	9.5	4.32
123	Top Funnel Repair Kits 20-30 HP	9.5	4.32
123	Top Funnel Repair Kits 40-60 HP	9.5	4.32
2-21-053	6" Stack Connection 4-10 HP	6.5	2.95
2-21-054	8" Stack Connection 15 HP	7	3.18
2-21-055	10" Stack Connection 20 HP	7.5	3.41
2-21-056	12" Stack Connection 30-60 HP	8	3.64
2-21-058	6" Stack to Pipe Adaptor 4-10 HP	6.5	2.95
2-21-059	8" Stack to Pipe Adaptor 15 HP	7	3.18
2-21-060	10" Stack to Pipe Adaptor 20 HP	8	3.64
2-21-061	12" Stack to Pipe Adaptor 30-60 HP	9	4.09
2-12-501	Castable Block Mix - per lb. (10 lbs. min.)-Use for top of bottom handhole up		
2-12-498	Castable Block Mix - 25 lb. bag -Use for top of bottom handhole up		
2-12-502	Kast Set - per lb. (10 lbs. minimum) - Use for making refractories		
2-12-500	Insulcrete - per lb. (10 lbs. min.) - Use for top of bottom handhole down		
2-12-497	Insulcrete - 50 lb. bag - Use for top of bottom handhole down		
5-12-020	Kaowool Sleeve for Bottom Funnel	0.9	0.41
4-12-018	Kaowool Insulation per sq. ft.		
2-12-507	Kaowool (panels) 7"		
2-21-015	Buckeye Stamping for Bottom Handhole 4-100 HP	1	0.45
2-21-092	Buckeye Stamping for Upper Handhole 4-15 HP	1	0.45
2-21-093	Buckeye Stamping for Upper Handhole 20-100 HP	1	0.45
2-23-171	Touch Up Paint - MICA Spray	1	0.45
4-23-014	Mica Paint - Quart	2	0.91
4-23-044	Mica Paint - Gallon	7.8	3.55
2-12-504	TIW Filler Insulation per sq ft		

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
	Burner Assembly - Parts (Common)		
2-40-605	1/3 HP 115/230/60/1 Burner Motor 3450 RPM	21	9.55
2-40-606	1/3 HP 230/460/60/3 Burner Motor 3450 RPM	20	9.09
2-40-603	1/3 HP 110/220/50/1 Burner Motor 2850 RPM	25	11.36
2-40-770	1/3 HP 380/50/3 Burner Motor 2850 RPM	28	12.73
2-40-608	3/4 HP 115/230/60/1 Burner Motor 3450 RPM	25	11.36
2-40-611	3/4 HP 230/460/60/3 Burner Motor 3450 RPM	22	10
2-40-609	3/4 HP 110/220/50/1 Burner Motor 2850 RPM	28	12.73
2-40-610	3/4 HP 380/50/3 Burner Motor 2850 RPM	22	10
2-40-613	1.5 HP 115/230/60/1 Burner Motor 3450 RPM	40	18.18
2-40-614	1.5 HP 110/220/50/1 Burner Motor 2850 RPM	45	20.45
2-40-615	1.5 HP 230/460/60/3 Burner Motor 2850/3450 RPM	31	14.09
2-40-771	1.5 HP 380/50/3 Burner Motor 2850 RPM	48	21.82
2-40-773	2.0 HP 380/50/3 Burner Motor 2850 RPM	48	21.82
2-40-616	2.0 HP 115/230/60/1 Burner Motor 3450 RPM	43	19.55
2-40-618	2.0 HP 230/460/60/3 Burner Motor 3450 RPM	33	15
2-40-617	2.0 HP 110/220/50/1 Burner Motor 2850 RPM	48	21.82
2-12-014	Pyrex Plate Glass 1 " - 4 -100 HP	0.1	0.05
2-45-025	Bakelite Terminal 90° for Electrode	0.05	0.02
2-45-026	Bakelite Terminal Straight for Electrode	0.05	0.02
2-45-017	Ignition Wire - per foot	0.01	0
2-11-116	Burner Scroll Casting - 9.5 HP	14	6.36
2-11-123	Burner Scroll Casting- 4-15 HP	30	13.64
5-20-059	Burner Scroll Casting - 20 HP	35	15.91
5-20-060	Burner Scroll Casting - 30 HP	40	18.18
5-20-061	Burner Scroll Casting - 40, 50 & 60 HP	50	22.73

Burner Fans:

	Size	HP	Applicable Fuel	Hz.		
2-30-407	5-1/2 x 1-1/2 x 5/8	4 HP	Propane or Nat. Gas	50/60 HZ	1.40	0.64
		6 HP	Propane	50/60 HZ	1.40	0.64
2-30-410	6-1/4 x 1-1/2 x 5/8	6 HP	Combination or Natural Gas	50/60 HZ	1.60	0.73
2-30-412	7 x 1-1/2 x 5/8	9.5-10 HP	Propane or Nat. Gas	50/60 HZ	2.00	0.91
2-30-414	7-11/16 X 1-1/2 x 5/8	15-20 HP	Propane or Nat. Gas	50/60 HZ	2.30	1.05
2-30-418	8-3/8 x 2 x 5/8	30 HP	Propane or Nat. Gas	50/60 HZ	3.15	1.43
2-30-421	8-3/8 x 2-1/2 x 1	40-50 HP	Propane or nat. Gas	50/60 HZ.	3.00	1.36
		60 HP	Propane or nat. Gas	50/60 HZ.	3.00	1.36

*When ordering burner fans, check for the correct part number on the back of the fan plate.

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
	Burner Assembly - Gas		
2-40-082	Ignition Transformer - Gas 115/60	9.5	4.32
2-40-083	Ignition Transformer - Gas 240/60	9.5	4.32
2-40-084	Ignition Transformer - Gas 120/50	10.3	4.68
2-40-085	Ignition Transformer - Gas 220/50	10.2	4.64
2-45-026	Straight Bakelite Terminal	0.03	0.01
4-45-010	Ignition Cable with 90° Bakelite Terminal	0.5	0.23
4-45-012	Flame Rod Cable with 90° Bakelite Terminal	0.5	0.23
2-20-019	Ignition Electrode	0.4	0.18
2-20-020	Flame Rod	0.4	0.18

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-30-118	Air Switch 4-100 HP	0.72	0.33
5-20-019	Burner Plate Gas - 4 HP	1	0.45
5-20-007	Burner Plate Gas - 6 & 10 HP	1	0.45
5-20-055	Burner Plate Gas - 9.5 HP	2	0.91
5-20-013	Burner Plate Gas - 15 & 20 HP	1	0.45
5-20-018	Burner Plate Gas - 30-60 HP	1	0.45
2-11-112	Air Deflector - Gas - 6 & 10 HP	11	5.00
2-11-075	Air Deflector - Gas - 9.5 HP	11	5.00
2-11-113	Air Deflector - Gas -15 HP	11	5.00
7-20-088	Air Deflector - Gas - 20 HP	24	10.91
7-20-090	Air Deflector - Gas - 30 HP	24	10.91
7-20-092	Air Deflector - Gas 40 - 60 HP	45	20.45
2-40-533	Gas Pressure Switch High-Low	3.25	1.48
2-40-211	Gas Pressure Switch - Low	4.9	2.23
2-40-212	Gas Pressure Switch - High	4.8	2.18
2-30-298	1/2" Pilot Gas Valve (4-100 HP)	1.5	0.68
2-30-301	1 " Main Gas Valve - V48A	3.2	1.45
2-30-302	1-1/4 " Main Gas Valve - V48A	4	1.82
2-30-303	1-1/2" Main Gas Valve - V48A	4.5	2.05
2-30-312	1-1/2" Gas Valve V5055A	4	1.82
2-30-313	2" Gas Valve V5055A	9.2	4.18
2-40-249	Gas Valve Body - P.O.C V5055C 1"	5	2.27
2-40-252	Gas Valve Body - P.O.C V5055C 1-1/4"	5.1	2.32
2-40-253	Gas Valve Body - P.O.C V5055C 1-1/2"	4.7	2.14
2-40-254	Gas Valve Body - P.O.C V5055C 2"	9.3	4.23
2-40-214	Actuator for 2", 2-1/2" and 3" Valve Body	13.70	6.23
2-40-220	Actuator for 2", 2-1/2" and 3" Valve Body w/Proof of Closure Switch	12.8	5.82
2-30-400	3/4" Vent Valve - 120V Normally Open	3.2	1.45
2-30-401	1" Vent Valve - 120V Normally Open	4.3	1.95
2-30-402	1-1/4" Vent Valve - 120V Normally Open	4.7	2.14
2-30-305	3/4" Solenoid GasValve	1.8	0.82
2-30-306	1" Solenoid Gas Valve	3.9	1.77
2-30-307	1-1/4" Solenoid Gas Valve	3.9	1.77
2-30-308	1-1/2" Solenoid Gas Valve	4.4	2.00
2-30-198	1/8" Gas Cock (Pet Cock)	0.25	0.11
2-30-111	1/2" Pilot Gas Cock	0.6	0.27
2-30-112	3/4" Main Gas Cock	1.5	0.68
2-30-113	1" Main Gas Cock	2	0.91
2-30-114	1-1/4 " Main Gas Cock	3	1.36
2-30-115	1-1/2 " Main Gas Cock	4.8	2.18
2-30-116	2" Main Gas Cock	4.8	2.18
2-30-021	1" Lubricated Gas Cock	5	2.27
2-30-022	1-1/4" Lubricated Gas Cock	6.5	2.95
2-30-013	1-1/2" Lubricated Gas Cock	7	3.18
2-30-012	2" Lubricated Gas Cock	10	4.55

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-30-102	1/2" Gas Pressure Regulator RV 48	0.7	0.32
2-30-104	1" Gas Pressure Regulator - RV 53	1.5	0.68
2-30-105	1-1/4 " Gas Pressure Regulator - RV 61	5	2.27
2-30-106	1-1/4" Gas Pressure Regulator - RV 81	5	2.27
2-30-107	1-1/2"Gas Pressure Regulator - RV 81	4.8	2.18
2-30-108	2" Gas Pressure Regulator - RV 91	8.3	3.77
2-20-002	CSA Air Gas Mixing Valve	1	0.45
7-20-060	Natural Gas Orifice - 4 HP Pre 2/89 3/4"	2	0.91
7-20-050	Natural Gas Orifice - 4 HP - Post 2/89 1"	2	0.91
7-20-051	Natural Gas Orifice - 6 HP	2	0.91
7-20-078	Natural Gas Orifice - 9.5 HP	2	0.91
7-20-052	Natural Gas Orifice -10 HP	2	0.91
7-20-023	Natural Gas Orifice - 15 HP - Post 2/89 1"	2	0.91
7-20-053	Natural Gas Orifice -15 HP - Pre 2/89 1-1/4"	2.5	1.14
7-20-054	Natural Gas Orifice - 20 HP	3	1.36
7-20-055	Natural Gas Orifice - 30 HP	3	1.36
7-20-265	Natural Gas Orifice - 40 HP	3.5	1.59
7-20-056	Natural Gas Orifice - 50 HP	3.5	1.59
7-20-057	Natural Gas Orifice - 60 HP	3.5	1.59
7-20-060	Propane Orifice - 4 HP - Pre 2/89 3/4"	2	0.91
7-20-030	Propane Orifice - 4 HP - Post 2/89 1"	2	0.91
7-20-061	Propane Orifice - 6 HP	2	0.91
7-20-062	Propane Orifice - 10 HP	2	0.91
7-20-033	Propane Orifice - 15 HP - Post 2/89 1"	2	0.91
7-20-063	Propane Orifice -15 HP - Pre 2/89 1-1/4"	2.5	1.14
7-20-064	Propane Orifice - 20 HP	3	1.36
7-20-065	Propane Orifice - 30 HP	3	1.36
7-20-275	Propane Orifice - 40 HP	3.5	1.59
7-20-066	Propane Orifice - 50 HP	3.5	1.59
7-20-067	Propane Orifice - 60 HP	3.5	1.59
2-30-177	Propane Spring RV48	0.05	0.02
2-30-178	Propane Spring RV53	0.05	0.02
2-30-179	Propane Spring RV61	0.05	0.02
2-30-180	Propane Spring RV81	0.05	0.02
2-30-181	Propane Spring RV91	0.05	0.02
7-30-001	Top Plate Assembly - 4 HP - Natural Gas	10	4.55
7-30-002	Top Plate Assembly - 6 & 10 HP - Natural Gas	15	6.82
5-30-001	Top Plate Assembly 9.5 HP - Natural Gas	15	6.82
7-30-003	Top Plate Assembly - 15 HP - Natural Gas	15	6.82
7-30-004	Top Plate Assembly - 20 HP - Natural Gas	35	15.91
7-30-005	Top Plate Assembly - 30 HP - Natural Gas	35	15.91
7-30-006	Top Plate Assembly - 40, 50 & 60 HP - Natural or Propane Gas	65	29.55
7-30-020	Top Plate Assembly - 4 HP - Propane Gas	10	4.55
7-30-021	Top Plate Assembly - 6 & 10 HP - Propane Gas	15	6.82
7-30-022	Top Plate Assembly - 15 HP - Propane Gas	15	6.82
7-30-023	Top Plate Assembly - 20 HP - Propane Gas	35	15.91
7-30-024	Top Plate Assembly - 30 HP - Propane Gas	35	15.91

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
7-30-025	Burner Plate Assembly - 4 HP - Natural Gas	7	3.18
7-30-026	Burner Plate Assembly - 6 HP - Natural Gas	8	3.64
7-30-123	Burner Plate Assembly - 9.5 HP Natural Gas	8	3.64
7-30-027	Burner Plate Assembly - 10 HP - Natural Gas	8	3.64
7-30-028	Burner Plate Assembly - 15 HP - Natural Gas	8	3.64
7-30-029	Burner Plate Assembly - 20 HP - Natural Gas	10	4.55
7-30-030	Burner Plate Assembly - 30 HP - Natural Gas	10	4.55
7-30-031	Burner Plate Assembly - 40, 50 HP - Natural Gas	12	5.45
7-30-032	Burner Plate Assembly - 60 Hp - Natural Gas	12	5.45
7-30-053	Burner Plate Assembly - 4 HP - Propane Gas	7	3.18
7-30-054	Burner Plate Assembly - 6 HP - Propane Gas	8	3.64
7-30-055	Burner Plate Assembly - 10 HP - Propane Gas	8	3.64
7-30-056	Burner Plate Assembly - 15 HP - Propane Gas	8	3.64
7-30-057	Burner Plate Assembly - 20 HP - Propane Gas	10	4.55
7-30-058	Burner Plate Assembly - 30 HP - Propane Gas	10	4.55
7-30-059	Burner Plate Assembly - 40, 50 HP - Propane Gas	12	5.45
7-30-060	Burner Plate Assembly - 60 HP - Propane Gas	12	5.45
7-54-1000	Gas Train Assembly- 4 HP - Natural Gas	20	9.09
7-54-1001	Gas Train Assembly - 6 HP- Natural Gas	23	10.45
7-54-1002	Gas Train Assembly -10 HP - Natural Gas	23	10.45
7-54-1003	Gas Train Assembly - 15 HP - Natural Gas - 1"	23	10.45
7-54-1004	Gas Train Assembly - 20 HP - Natural Gas - 1-1/4"	27	12.27
7-54-1005	Gas Train Assembly - 30 HP - Natural Gas	27	12.27
7-54-1006	Gas Train Assembly - 40 - 50 HP - Natural Gas	70	31.82
7-54-1007	Gas Train Assembly- 60 HP- Natural Gas	70	31.82
7-54-1050	Gas Train Assembly - 4 HP - Propane Gas	20	9.09
7-54-1051	Gas Train Assembly - 6 HP - Propane Gas	25	11.36
7-54-1052	Gas Train Assembly -10 HP - Propane Gas	25	11.36
7-54-1053	Gas Train Assembly -15 HP - Propane Gas	25	11.36
7-54-1054	Gas Train Assembly - 20 HP - Propane Gas	30	13.64
7-54-1055	Gas Train Assembly - 30 HP - Propane Gas	30	13.64
7-54-1056	Gas Train Assembly - 40 - 50 HP - Propane Gas	70	31.82
7-54-1057	Gas Train Assembly - 60 HP - Propane Gas	70	31.82
	Water Column		
5-20-022	Fulton Water Column Bottle Casting -4-100 HP	20	9.09
2-30-151	MM 150 Pump Control	25	11.36
2-30-193	MM 150 - M/R Control	25	11.36
2-30-152	MM 150 HD Assembly	25	11.36
2-30-192	MM 150-M-HD M/R Head	25	11.36
2-12-125	MM 150-14 Gasket	0.05	0.02
2-30-136	MM 157 Pump Control and Low Water Cutoff	39.7	18.05
2-30-137	MM 53-2 Boiler Feeder and Low Water Cutoff	38.5	17.5
2-45-144	MM Mercury Switch - 2 Wire	1	0.45
2-45-143	MM Mercury Switch - 3 Wire	1	0.45
2-30-149	Water Gauge Glass Valves w/Ball Checks	1.5	0.68
2-30-047	Try Cocks	0.4	0.18
2-12-065	8-5/8" Extra Heavy Gauge Glass	0.05	0.02
2-12-008	9-1/4 Water Gauge Glass - standard	0.05	0.02
2-12-007	9-1/4" Extra Heavy Gauge Glass	0.1	0.05
2-12-017	9-1/4" Water Gauge Glass -Corning	0.05	0.02

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-12-018	10" Water Gauge Glass- MM	0.06	0.03
2-12-071	12" Water Gauge Glass	0.07	0.03
2-12-063	14"Water Gauge Glass	0.08	0.04
2-30-155	Conbraco 250# GG Valve w/Ball Check (9.5 HP)	1.5	0.68
2-12-020	Brass Water Gauge Glass Gasket	0.0018	0
2-12-019	Rubber Water Gauge Glass Gasket	0.004	0
2-12-080	Teflon Water Gauge Gaskets	0.01	0
2-35-514	Brass Packing Nut for Gauge Glass Valve	0.1	0.05
2-30-330	Gauge Glass Protector Rods	0.04	0.02
2-12-022	Lucite Gauge Glass Guard for 9-1/4" Glass	0.4	0.18
2-12-024	Lucite Gauge Glass Guard for 10" Glass	0.5	0.23
2-12-021	Lucite Gauge Glass Guard for 12" Glass (53MM)	0.06	0.03
2-12-204	Lucite Gauge Glass Guard - 9.5 HP	0.045	0.02
4-21-010	Water Column Electrode Basket & Cover	0.5	0.23
4-30-050	Set of four (4) Water Level Probes & Plugs - 4 HP	1.3	0.59
4-30-052	Set of four (4) Water Level Probes & Plugs - 6-60 HP	1.3	0.59
4-30-042	Set of 3 Water Column Probes	0.8	0.36
2-20-010	Pump Off Probe - 7-1/4 "	0.2	0.09
2-20-011	Pump On Probe - 9-1/4"	0.2	0.09
2-20-012	Low Water Probe in Water Column -11-1/4"	0.3	0.14
2-20-017	Low Water Probe in Boiler- 17-1/8"	0.5	0.23
2-21-012	Probe Cover - 2"	1	0.45
2-21-013	Probe Cover - 4"	1	0.45
2-30-398	1/4"Male-Female Ball Valve for Water Column	0.6	0.27
2-40-021	Probe Basket	0.05	0.02
	Panel Box Parts		
2-40-420	Fulton Pump Relay-120V	0.5	0.23
2-40-421	Fulton Burner Relay - 120V	0.5	0.23
2-40-422	Base for Fulton Pump Relay	0.25	0.11
2-40-423	Base for Fulton Burner Relay	0.25	0.11
2-40-405	Fulton Pump Relay - 220v	0.5	0.23
2-40-406	Fulton Burner Relay - 220v	0.5	0.23
2-12-090	Spring Retainer for burner/pump relay	0.001	0
2-40-403	IDIDO-120VRelay	2	0.91
2-40-402	IGIDO - 120V Relay	2	0.91
2-40-400	IGIDO-A-120VRelay	2	0.91
2-40-401	ID2DO - 220V Relay	2	0.91
4-45-050	Set of three (3) Coils for ID or IG Type Relay	1	0.45
4-45-051	Set of three (3) Coils ID2D0 - 220V	1	0.45
2-40-131	General Purpose Relay (Ice Cube) - AB	0.8	0.36
2-40-096	Base for Ice Cube Relay	0.1	0.05
2-45-091	On/Off Switch	0.05	0.02
2-45-092	Manual Reset Switch	0.05	0.02
2-45-090	Night Switch for two (2) Pressuretrols	0.05	0.02
2-40-552	4" Alarm Bell	1	0.45
2-40-551	120V Transformer for Bell	1	0.45
2-40-550	220V Transformer for Bell	1	0.45

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-45-106	Green Panel Box Indicating Light - 120V	0.1	0.05
2-45-107	White Panel Box Indicating Light -120V	0.1	0.05
2-45-108	Amber Panel Box Indicating Light - 120V	0.1	0.05
2-45-110	Red Panel Box Indicating Light -120V	0.1	0.05
2-45-112	Green Panel Box Indicating Light - 220V	0.1	0.05
2-45-115	White Panel Box Indicating Light - 220V	0.1	0.05
2-45-116	Amber Panel Box Indicating Light - 220V	0.1	0.05
2-45-114	Red Panel Box Indicating Light - 220V	1	0.45
2-45-412	AB Green Panel Light 120 V - NEMA 4	0.02	0.01
2-45-413	AB Amber Panel Light 120 V - NEMA 4	0.02	0.01
2-45-411	AB Red Panel Light 120 V - NEMA 4	0.02	0.01
2-45-410	AB White Panel Light 120 V - NEMA 4	0.02	0.01
2-40-567	Motor Contactor - AB - 100 - A09ND3- 120V - 4-60 HP	0.8	0.36
2-40-568	Motor Contactor - AB - 100 - A09NA3- 220V - 4-60 HP	0.8	0.36
2-40-565	Overload - AB - BSB 16	0.45	0.2
2-40-657	Overload - AB - BSB 15	0.45	0.2
2-40-648	Overload - AB - BSB 22	0.45	0.2
2-40-571	Overload - AB - BSB 30	0.45	0.2
2-40-575	Overload - AB - BSC 10	0.45	0.2
2-40-643	Overload - AB - BSC 15	0.45	0.2
2-40-652	Overload - AB - BSC 24	0.45	0.2
2-40-572	Overload - AB - BSB 42	0.45	0.2
2-40-573	Overload - AB - BSB 60	0.45	0.2
2-40-574	Overload - AB - BSB 80	0.45	0.2
2-40-566	Overload - AB - BSB 90	0.45	0.2
2-40-200	Motor Starter Relay -120V - 20 AMP	0.6	0.27
2-40-202	Motor Starter Relay - 120V - 30 AMP	0.5	0.23
2-40-201	Motor Starter Relay - 220V - 20 AMP	0.4	0.18
2-40-203	Motor Starter Relay - 220V - 30 AMP	0.5	0.23
4-40-050	Night Heating Pressuretrol Set Up	3.5	1.59
2-40-227	Pressuretrol L404A - 2-15 PSI	1.7	0.77
2-40-228	Pressuretrol L404A - 5-50 PSI	2	0.91
2-40-229	Pressuretrol L404A - 10-150 PSI	2	0.91
2-40-230	Pressuretrol L404A - 20-300PSI	2.7	1.23
2-40-231	Pressuretrol L404C - 2-15 PSI	2	0.91
2-40-232	Pressuretrol L404C - 5-50 PSI	2	0.91
2-40-233	Pressuretrol L404C - 10-150 PSI	2	0.91
2-40-234	Pressuretrol L404C - 20-300 PSI	2.7	1.23
2-40-161	Flame Scanner (Mini-Peeper)	0.5	0.23
2-40-260	RM7895A Programmer 20-50 HP - 120 V	2	.91
2-40-262	RM7800M Programmer 60-100 HP - 120 V	2.5	1.14
2-40-265	7 Second Prepurge Timer	0.1	0.05
2-40-266	30 Second Prepurge Timer	0.1	0.05
2-40-267	60 Second Prepurge Timer	0.1	0.05
2-40-268	RM7800 Amplifier - For Flame Rod	0.3	0.14
2-40-269	RM7800 Amplifier - For UV Amp	0.2	0.09

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-40-161	Mini Peeper For All 7800	0.5	0.23
2-40-270	Base For All 7800	0.5	0.23
2-40-272	Display Module for 7800 Controls English (Also Available in Spanish)	0.5	0.23
2-40-247	Remote Mounting Bracket for 7800	0.65	0.3
2-40-248	Extension Cable		
2-40-261	EC7830A Programmer 220/50	2	0.91
2-40-276	Timer 7 for EC7830/50	0.1	0.05
2-40-273	Timer 30 for EC7830/50	0.1	0.05
2-40-274	UV - Amplifier for EC7830/50	0.2	0.09
	Boiler Trim		
5-35-100	9.5 HP Steam Orifice	2	0.91
2-30-396	1" Spring Loaded Check Valve - 200#	2.55	1.16
2-30-397	1-1/4" Spring Loaded Check Valve - 200#	3.8	1.73
2-30-019	1/4" Ball Valve - 200#	0.6	0.27
2-30-008	1/2" BallValve-200#	0.7	0.32
2-30-027	3/4" BallValve-200#	1.4	0.64
2-30-026	1" Ball Valve - 200#	1.75	0.8
2-30-001	1" MxF Ball Valve 200#	2	0.91
2-30-017	1-1/4" Ball Valve - 200#	3.1	1.41
2-30-018	1-1/2" Ball Valve - 200#	4.7	2.14
2-30-025	2" Ball Valve - 200#	6.35	2.89
2-30-208	3" Ball Valve - 200#	18	8.18
2-30-391	1"Y Type Blowdown Valve - 200#	4	1.82
2-30-392	1-1/4" Y Type Blowdown Valve - 200#	5.5	2.5
2-30-393	1-1/2" Y Type Blowdown Valve - 200#	8.4	3.82
2-30-007	1" Quick Action Blowdown Valve	13	5.91
2-30-014	1-1/4" Quick Action Blowdown Valve	14	6.36
2-30-023	1-1/2" Quick Action Blowdown Valve	23	10.45
2-40-133	Timer for Automatic Blowdown System	0.8	0.36
2-30-386	1" Motorized Valve for Automatic Blowoff	9.8	4.45
2-30-387	1-1/4" Motorized Valve for Automatic Blowoff	10.7	4.86
2-30-403	1-1/2" Motorized Valve for Automatic Blowoff	12.6	5.73
2-30-1066	1/2" Steam Solenoid Valve - 120V	2.3	1.05
2-30-122	3/4" Steam Solenoid Valve - 120V	2.5	1.14
2-30-146	1" Steam Solenoid Valve - 120V	4.5	2.05
2-30-147	1-1/4 " Steam Solenoid Valve - 120V	4.9	2.23
2-30-148	1-1/2" Steam Solenoid Valve - 120V	6.3	2.86
2-30-214	3/4" 15# Series 19 V-Stamped Safety Valve	1	0.45
2-30-215	1" 15# Series 19 V-Stamped Safety Valve	1.1	0.5
2-30-216	1-1/4" 15# Series 19 V-Stamped Safety Valve	1.85	0.84
2-30-016	1-1/2" 15# Series 19 V-Stamped Safety Valve	2	0.91
2-30-217	2" 15# Series 19 V-Stamped Safety Valve	2.5	1.14
2-30-062	1/2"-100# Safety Valve	1.2	0.55
2-30-063	1/2"-125# Safety Valve	1.3	0.59
2-30-064	3/4"-15# Safety Valve	1	0.45
2-30-065	3/4"-30# Safety Valve	1.8	0.82
2-30-067	3/4"-75# Safety Valve	3.2	1.45

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-30-068	3/4"-100# Safety Valve	2	0.91
2-30-069	3/4"-125# Safety Valve	2	0.91
2-30-070	3/4"-150# Safety Valve	1.4	0.64
2-30-071	3/4"-200# Safety Valve	5.1	2.32
2-30-073	3/4"-300# Safety Valve	2.35	1.07
2-30-074	1"-15# Safety Valve	1.1	0.5
2-30-075	1"-75# Safety Valve	4	1.82
2-30-076	1"-100# Safety Valve	4.1	1.86
2-30-077	1"-125# Safety Valve	4.1	1.86
2-30-078	1"-150# Safety Valve	4.1	1.86
2-30-079	1"-200# Safety Valve	4	1.82
2-30-081	1"-300# Safety Valve	5	2.27
2-30-082	1-1/4 "-15# Safety Valve	1.85	0.84
2-30-083	1-1/4"-100# Safety Valve	6.6	3
2-30-084	1-1/4"-125# Safety Valve	6.75	3.07
2-30-085	1-1/4"-150# Safety Valve	6.8	3.09
2-30-086	1-1/2"-15# Safety Valve	2	0.91
2-30-087	1-1/2"-100# Safety Valve	12.4	5.64
2-30-088	1-1/2"-125# Safety Valve	10.9	4.95
2-30-089	1-1/2"-150# Safety Valve	12.3	5.59
2-35-518	1/4" Steel Pigtail Syphon for Steam Gauge Assembly- Long	0.6	0.27
2-30-202	Pressure & Temp Gauge	1	0.45
2-30-326	0-30 PSI Steam Pressure Gauge	0.5	0.23
2-30-334	0-60 PSI Steam Pressure Gauge	0.5	0.23
2-30-333	0-200 PSI Steam Pressure Gauge	0.5	0.23
2-30-332	0-300 PSI Steam Pressure Gauge	0.5	0.23
2-30-327	0-600 PSI Steam Pressure Gauge	0.5	0.23
2-12-025	Teflon Disc for 1" Y Valve	0.2	0.09
2-11-015	Brass Seat for 1" Y Valve	0.1	0.05
2-12-026	Teflon Disc for 1-1/4 " Y Valve	0.5	0.23
2-11-016	Brass Seat for 1-1/4 " Y Valve	0.1	0.05
2-12-027	Teflon Disc for 1-1/2" Y Valve	0.2	0.09
2-11-017	Brass Seat for 1-1/2" Y Valve	0.1	0.05
2-12-028	Teflon Disc for 2" Y Valve	0.2	0.09
2-11-018	Brass Seat for 2" Y Valve	0.1	0.05
	Test Equipment/Tools		
2-40-090	Test Leads	0.6	0.27
2-40-215	Microampmeter - W136	2	0.91
2-60-100	Jr. Amprobe - Y25	1	0.45
2-60-102	Pocket Draft Meter	1	0.45
2-60-103	All Purpose Draft Meter	3	1.36
2-60-104	CO Tester-Gas	15	6.82
2-60-105	CO Tubes	0.25	0.11
2-60-106	StackThermometer	4	1.82
2-60-108	SmokeTester-Oil	2	0.91
2-60-110	Fisher Gauge - 50 PZ	1	0.45
2-60-112	Flue Cleanout Brush	0.8	0.36
2-60-247	Flue Brush - Pipe Type - 2-1/2" - 100 HP	1	0.45
2-60-248	Flue Brush - Pipe Type - 2" - 80 HP	1	0.45

Parts

Part No.	Description			Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
5-10-397	Tee Handle Wrench			2.7	1.23
2-20-110	Fan Puller - 5/8" Hub			2	0.91
2-20-115	Fan Puller - 1" Hub			2	0.91
	Barometric Controls				
2-30-092	6" MGI 4, 6 & 10 HP - Gas			3	1.36
2-30-095	8" MG1 15 HP - Gas			4	1.82
2-30-097	10" M&MG2 20 HP - Oil, Gas, Comb			8	3.64
2-30-098	12" M&MG2 30 HP - Oil, Gas, Comb.			12	5.45
2-30-099	14" M&MG2 50 - 100 HP - Oil, Gas, Comb.			16	7.27
2-30-0415	16" M&MG2			25	11.36
	Spare Parts Kits				
4-50-000001	Spare Parts Kit No. 1		4-30 BHP Gas Consists of:	4	1.82
	Qty	Part No.	Description		
	6	2-12-000004	Handhole Gaskets		
	1	2-12-000017	9-1/4" Gauge Glass		
	2	2-12-000019	Water Gauge Glass Rubber		
	2	2-12-000020	Water Gauge Glass Fiber		
	1	2-20-000019	Ignition Electrode		
	1	2-20-000020	Flame Rod		
	1	5-10-000397	Tee Handle Wrench		
	1	4-30-000052	Set of (4) Plugs and Probes		
4-50-000002	Spare Parts Kit No. 2		50-100 BHP Gas	4	1.82
	6	2-12-000004	Handhole Gaskets		
	1	2-12-000017	9-1/4" Gauge Glass		
	2	2-12-000019	Water Gauge Glass Rubber		
	2	2-12-000020	Water Gauge Glass Fiber		
	1	2-20-000019	Ignition Electrode		
	1	5-10-000397	Tee Handle Wrench		
	1	4-30-000052	Set of (4) Plugs and Probes		
2-12-515	Burner Plate Gasket 4 HP Gas			0.05	0.02
2-12-516	Burner Plate Gasket 6-20 HP Gas			0.05	0.02
2-12-517	Burner Plate Gasket 30-100 HP Gas			0.06	0.03
2-12-023	Screws (11)			0.001	0.00
2-12-513	Bottom Cleanout Gasket Only			0.5	0.23
2-12-514	Combination Gasket			0.05	0.02
4-12-100	Flue Cover Plate Gasket - 4 HP			1.5	0.68
4-12-102	Flue Cover Plate Gasket - 6 HP			1.5	0.68
4-12-104	Flue Cover Plate Gasket -10 HP			1.5	0.68
4-12-106	Flue Cover Plate Gasket -15 HP			1.8	0.82
4-12-108	Flue Cover Plate Gasket - 20 HP			2	0.9
4-12-110	Flue Cover Plate Gasket - 30 HP			2	0.91
4-12-112	Flue Cover Plate Gasket - 40-60 HP			2.5	1.14
2-12-210	1/4" Braided Rope Gasket 4-100 HP - price per foot			0.25	0.11
					0.00
2-12-077	Handhole Funnel Gasket 20-100 HP Top			0.05	0.02
2-12-078	Handhole Funnel Gasket 4-15 HP Top			0.05	0.02
2-12-079	Handhole Funnel Gasket 4-100 HP Bottom			0.05	0.02

Parts

Part No.	Description	Approx. Net Weight (lbs.)	Approx. Net Weight (kgs.)
2-12-528	Scroll Gasket - 4 HP	1	0.45
2-12-529	Scroll Gasket - 6-15 HP	1	0.45
2-12-530	Scroll Gasket- 20-30 HP	1	0.45
2-12-531	Scroll Gasket- 40-60 HP	1	0.45
2-12-537	Stack Extension Gasket 6" 4-10 HP	1	0.45
2-12-538	Stack Extension Gasket 8" 15 HP	1	0.45
2-12-539	Stack Extension Gasket 10" 20 HP	1	0.45
2-12-540	Stack Extension Gasket 12" 30-60 HP	1	0.45
2-12-518	Top Plate Gasket - 4 HP (Old Style)	1	0.45
2-12-519	Top Plate Gasket - 4-15 HP	1	0.45
2-12-520	Top Plate Gasket - 20-30 HP	1	0.45
2-12-521	Top Plate Gasket - 40-60 HP	1	0.45
4-12-522	9.5 HP Gas, Oil, & Comb Gasket Kit	5	2.27
4-12-500	4-15 HP Gas, Oil, & Comb Gasket Kit	5	2.27
4-12-506	20-30 HP Gas, Oil, & Comb Gasket Kit	6	2.73
4-12-512	40-60 HP Gas, Oil, & Comb Gasket Kit	10	4.55

See the following component assembly drawings to assist with parts identification.

Parts

Parts

Part No.*	Burner Motor (1)	RPM	HP
2-40-605	1/3 HP 115/230/60/1	3450	4-15
2-40-606	1/3 HP 230/460/60/3	3450	4-15
2-40-603	1/3 HP 110/220/50/1	2850	4-15
2-40-770	1/3 HP 380/50/3	2850	4-15
2-40-608	3/4 HP 115/230/60/1	3450	20-30
2-40-611	3/4 HP 230/460/60/3	3450	20-30
2-40-609	3/4 HP 110/220/50/1	2850	20-30
2-40-771	1.5 HP 380/50/3	2850	40-60
2-40-613	1.5 HP 115/230/60/1	3450	40-60
2-40-615	1.5 HP 230/460/60/3	3450	40-60
2-40-614	1.5 HP 110/220/50/1	2850	40-60

***The correct part number is located on the burner motor.**

Part No.	Burner Scroll Casting (2)	HP
2-11-123	Burner Scroll Casting	4-15
5-20-059	Burner Scroll Casting	20
5-20-060	Burner Scroll Casting	30
2-11-126	Burner Scroll Casting	40 -60

Part No.*	Burner Fan (3)	Fuel	HZ	HP
2-30-407	5-1/2 x 1-1/2 x 5/8	LP/N.Gas	50/60	4
		LP	50/60	6
2-30-410	6-1/4 x 1-1/2 x 5/8	N.Gas	50/60	6
2-30-412	7 x 1-1/2 x 5/8	LP/N. Gas	50/60	9.5-10
2-30-414	7-11/16 X 1-1/2 x 5/8	LP/N. Gas	50/60	15-20
2-30-418	8-3/8 x 2 x 5/8	LP/N. Gas	50/60	30
2-30-421	8-3/8 x 2-1/2 x 1	LP/N. Gas	50/60	40-50.
2-30-425	9 -3/16 X 2-1/2 x 1	LP/N. Gas	50/60	60

***The correct part number is located on the back of the fan plate.**

Part No.	Ignition Transformer (4)
2-40-082	120/60/1
2-40-083	240/60/1
2-40-084	120/50/1
2-40-085	240/50/1

Part No.	Air Deflector (5)	HP
2-11-112	Air Deflector	4-10
2-11-075	Air Deflector	9.5
2-11-113	Air Deflector	15-20
7-20-090	Air Deflector	30
7-20-092	Air Deflector	40-60

Part No.		
Nat. Gas Orifice	LP Gas Orifice (6)	HP
7-20-050	7-20-030	4
7-20-051	7-20-061	6
2-20-078	consult factory	9.5
7-20-052	7-20-062	10
7-20-023	7-20-033	15
7-20-054	7-20-064	20
7-20-055	7-20-065	30
7-20-265	7-20-275	40
7-20-056	7-20-066	50
7-20-057	7-20-067	60

Part No.	Air Switch (7)	HP
2-30-118		4-100

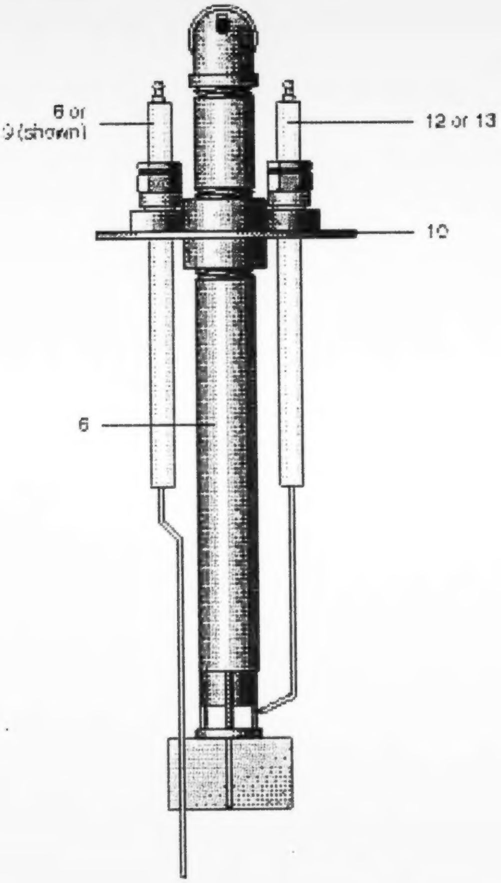
Part No.	Flame Detectors		HP
2-40-161	Scanner for 7800 Series	(8)	50-100
2-20-020	Flame Rod	(9)	4-30

Part No.	Burner Plate (10)	HP
5-20-019	Gas Burner Plate	4
5-20-007	Gas Burner Plate	6-10
5-20-055	Gas Burner Plate	9.5
5-20-013	Gas Burner Plate	15-20
5-20-018	Gas Burner Plate	30-60

Part No.	Air Gate (11)	HP
5-20-017	Air Gate	4-10
5-20-012	Air Gate	15
5-20-011	Air Gate	20-30
5-20-066	U.K. Air Gate	40-100

Part No.	Electrode Parts		HP
2-20-019	Ignition Electrode	(12)	4-60
2-20-033	Ignition Electrode - VMP	(13)	40-100
2-12-014	Pyrex Plate Glass 1"	(14)	4-100

Parts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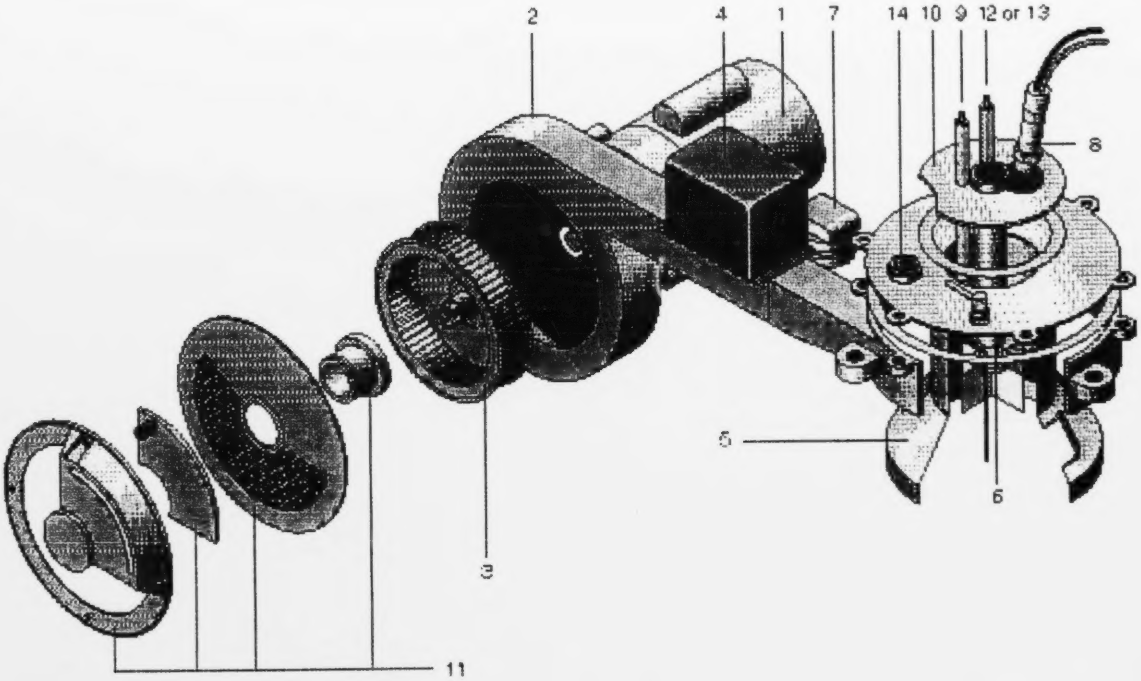
Gas Burner
Ignition Assembly

Gas Burner Components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Parts

Gas Head Assemblies

Part No.	Complete Gas Head Assembly	HP
7-54-1000	Natural Gas	4
7-54-1001	Natural Gas	6
7-54-1002	Natural Gas	10
7-54-1003	Natural Gas	15
7-54-1004	Natural Gas	20
7-54-1005	Natural Gas	30
7-54-1006	Natural Gas	40-50
7-54-1007	Natural Gas	60
7-54-1050	Propane Gas	4
7-54-1051	Propane Gas	6
7-54-1052	Propane Gas	10
7-54-1053	Propane Gas	15
7-54-1054	Propane Gas	20
7-54-1055	Propane Gas	30
7-54-1056	Propane Gas	40-50
7-54-1057	Propane Gas	60

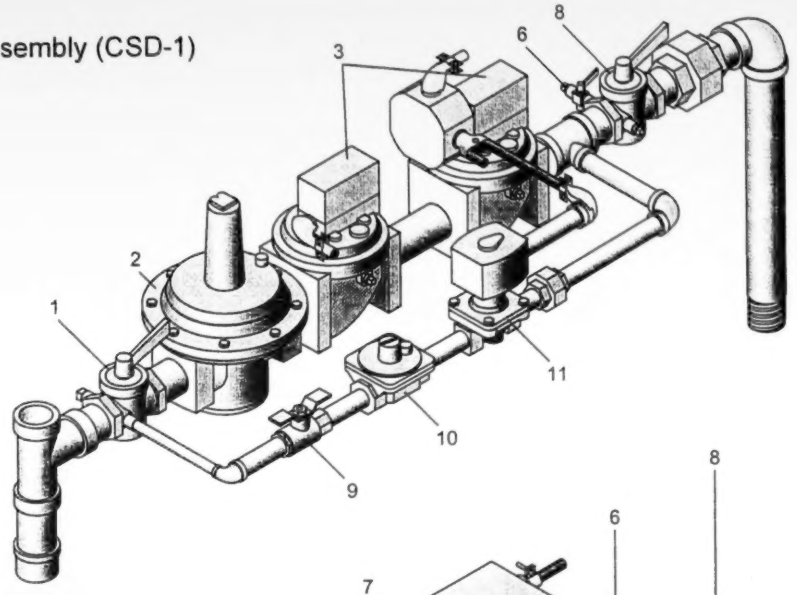
Gas Train Components

Part No.	Description	HP
2-30-113	Main Gas Manual Shut Off Valve **(1)**	4-15
2-30-114	Main Gas Manual Shut Off Valve	20
2-30-115	Main Gas Manual Shut Off Valve	30-50
2-30-116	Main Gas Manual Shut Off Valve	60
2-30-104	Main Gas Pressure Regulator **(2)**	4-15
2-30-105	Main Gas Pressure Regulator	20
2-30-107	Main Gas Pressure Regulator	30-50
2-30-108	Main Gas Pressure Regulator	60
2-30-301	Main Automatic Gas Valve **(3)**	4-15
2-30-302	Main Automatic Gas Valve	20
2-30-303	Main Automatic Gas Valve	30-50
2-40-220	Main Automatic Gas Valve Actuator w/Proof of Closure **(4)**	60-100
2-40-254	Main Automatic Gas Valve Body **(5)**	60
2-30-198	Leak Test Valve **(6)**	4-100
2-40-533	High/Low Gas Pressure Switch **(7)**	60-100

Part No.	Description	HP
2-30-113	Final Manual Shut-off Valve **(8)**	4-15
2-30-114	Final Manual Shut-off Valve	20
2-30-115	Final Manual Shut-off Valve	30-50
2-30-116	Final Manual Shut-off Valve	60
2-30-111	Pilot Gas Manual Shut-off Valve **(9)**	4-100
2-30-102	Pilot Gas Pressure Regulator **(10)**	4-100
2-30-298	Pilot Gas Automatic Shut-off Valve **(11)**	4-100

Parts

Gas Head Assembly (CSD-1)
4 to 50 HP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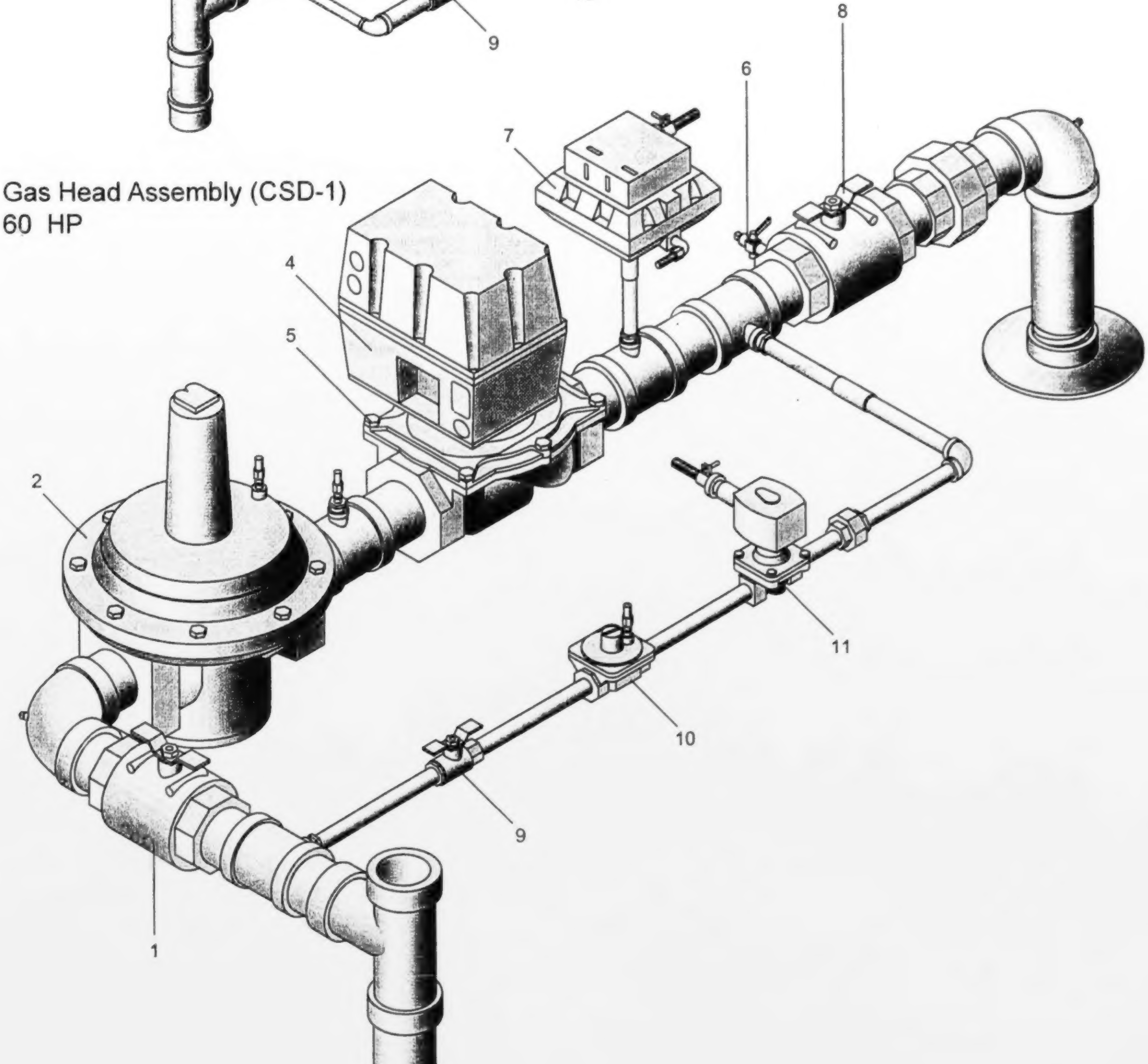
Gas Head Assembly (CSD-1)
60 HP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Parts

Panel Box Parts

Part No.	Relays	HP
2-40-420	Fulton Pump Relay - 120V	4-100
2-40-421	Fulton Burner Relay - 120V	4-100
2-40-422	Base for Fulton Pump Relay	4-100
2-40-423	Base for Fulton Burner Relay	4-100
2-40-405	Fulton Pump Relay 220V	4-100
2-40-406	Fulton Burner Relay 220V	4-100
2-40-403	IDIDO-120V Relay	4-100
2-40-402	IGIDO - 120V Relay (manual reset)	4-100
2-40-400	IGIDO-A-120V Relay	4-100
2-40-401	ID2DO - 220V Relay	4-100

Part No.	Switches	HP
2-45-091	On/Off Switch	4-100
2-45-092	Manual Reset Switch	4-100
2-45-090	Night Switch for two (2) Pressuretrols	4-100

Part No.	Motor Starter Relays (Single Phase)	HP
2-40-200	Motor Starter Relay - 120V - 20 AMP	4-50
2-40-202	Motor Starter Relay - 120V - 30 AMP	4-50
2-40-201	Motor Starter Relay - 220V - 20 AMP	4-50
2-40-203	Motor Starter Relay - 220V - 30 AMP	4-50

Part No.	Flame Safeguard Control	HP
2-40-260	RM7895F Programmer	4-50
2-40-262	RM7800M Programmer	60-100
2-40-272*	Display Module For 7800 Series Controls	60-100

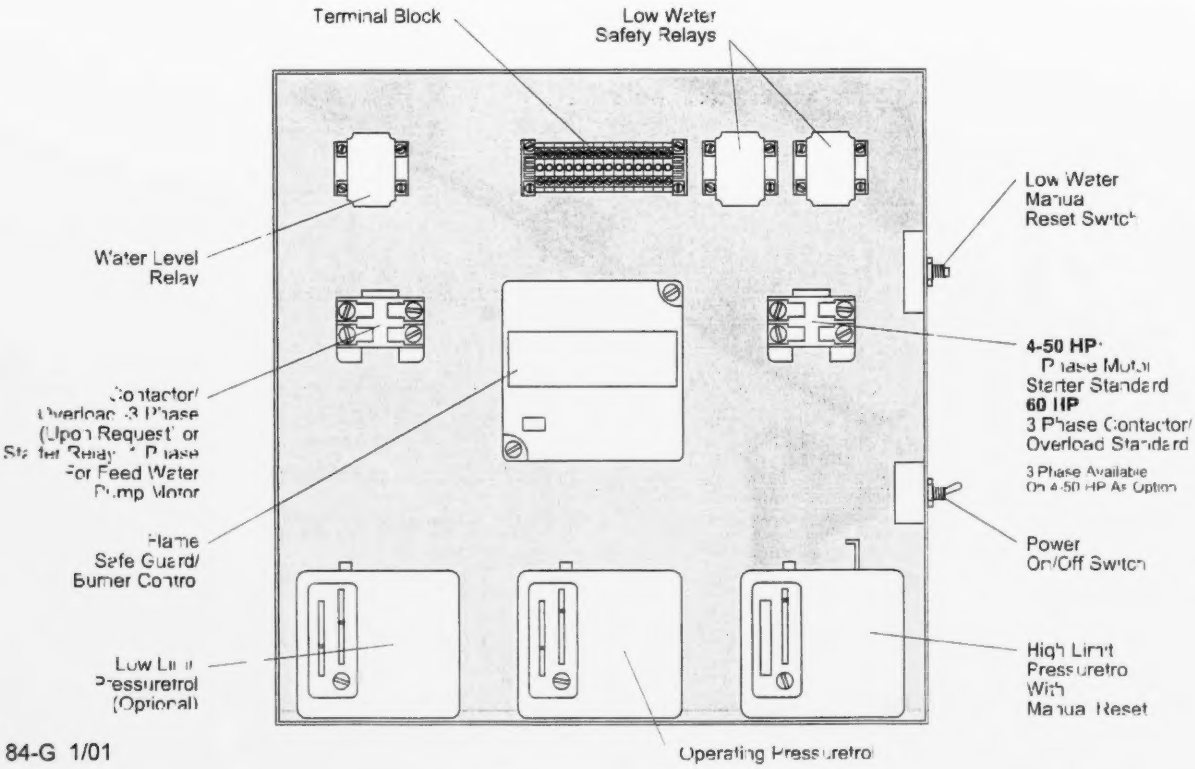
*Standard on 60-100 HP; optional 4-50 HP.

Part No.	Motor Contactors (Three Phase)	HP
2-40-568	Contactor -AB -100- A09NA3- 220V	4-60
2-40-567	Contactor- AB -100- A09ND3-120V	4-60
2-40-641	Contactor -AB -100- A12NA3- 220V	80-100
2-40-642	Contactor- AB -100- A12ND3-120V	80-100
2-40-565	Overload - AB - BSB 16	
2-40-657	Overload - AB - BSB 15	
2-40-648	Overload - AB - BSB 22	
2-40-571	Overload - AB - BSB 30	
2-40-575	Overload - AB - BSC 10	
2-40-643	Overload - AB - BSC 15	
2-40-652	Overload - AB - BSC 24	
2-40-572	Overload - AB - BSB 42	
2-40-573	Overload - AB - BSB 60	
2-40-574	Overload - AB - BSB 80	
2-40-566	Overload - AB - BSB 90	

Note: Contactor Overload depends on motor h.p. and voltage

Part No.	Pressuretrols	HP
4-40-050	Night Heating Pressuretrol Set Up	4-100
2-40-227	Pressuretrol L404A - 2-15 PSI	4-100
2-40-228	Pressuretrol L404A - 5-50 PSI	4-100
2-40-229	Pressuretrol L404A - 10-150 PSI	4-100
2-40-230	Pressuretrol L404A - 20-300 PSI	4-100
2-40-231	Pressuretrol L404C - 2-15 PSI	4-100
2-40-232	Pressuretrol L404C- 5-50 PSI	4-100
2-40-233	Pressuretrol L404C - 10-150 PSI	4-100
2-40-234	Pressuretrol L404C - 20-300 PSI	4-100

Note: Correct pressuretrol is based on boiler trim pressure.


Terminal Block
Low Water Safety Relays
Low Water Manual Reset Switch
Water Level Relay
Contactor/ Overload 3 Phase (Upon Request) or Starter Relay 1 Phase For Feed Water Pump Motor
4-50 HP: 1 Phase Motor Starter Standard
60 HP
3 Phase Contactor/ Overload Standard
3 Phase Available On 4-50 HP As Option
Flame Safe Guard/ Burner Control
Power On/Off Switch
Low Limit Pressuretrol (Optional)
High Limit Pressuretrol With Manual Reset
Operating Pressuretrol

Parts

Water Column - Parts

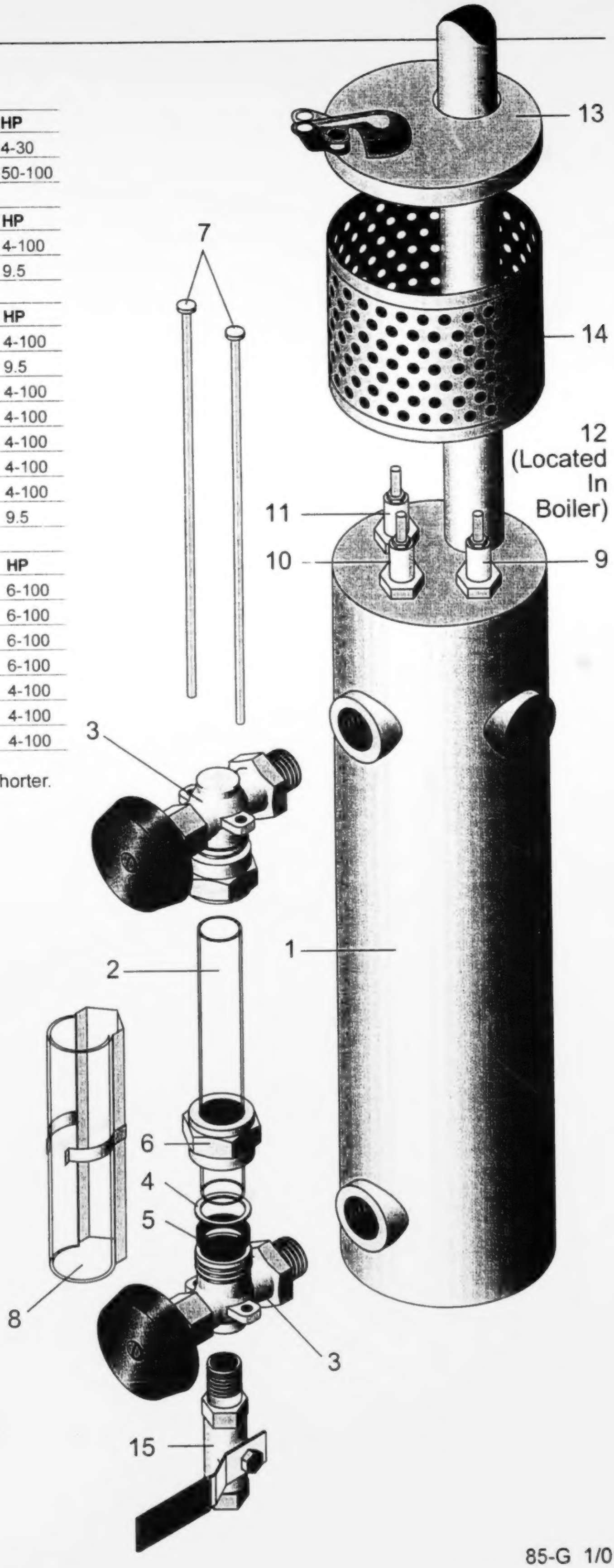
Part No.	Water Column Bottle Casting (1)	HP
5-20-022	Water Column Bottle Casting	4-30
5-20-048	Water Column Bottle Casting	50-100

Part No.	Water Gauge Glass (2)	HP
2-12-017	9-1/4" Water Gauge Glass - Corning	4-100
2-12-065	8-5/8" Extra Heavy Gauge Glass	9.5

Part No.	Water Gauge Glass Trim	HP
2-30-149	Water Gauge Glass Valves w/Ball Checks **(3)**	4-100
2-30-155	Conbraco 250 w/Ball Check **(3)**	9.5
2-12-020	Brass Water Gauge Glass Gasket **(4)**	4-100
2-12-019	Rubber Water Gauge Glass Gasket **(5)**	4-100
2-35-514	Brass Packing Nut for Gauge Glass Valve **(6)**	4-100
2-30-330	Gauge Glass Protector Rods **(7)**	4-100
2-12-022	Lucite Gauge Glass Guard -9-1/4" Glass **(8)**	4-100
2-12-204	Lucite Gauge Glass Guard -8-5/8" Glass **(8)**	9.5

Part No.	Water Level Probes & Plugs	HP
2-20-010	*Pump Off Probe - 7-1/4 " **(9)**	6-100
2-20-011	*Pump On Probe - 9-1/4" **(10)**	6-100
2-20-012	*Low Water Probe in Water Column-11-1/4" **(11)**	6-100
2-20-017	Low Water Probe in Boiler- 17-1/8" **(12)**	6-100
2-21-012	Probe Cover **(13)**	4-100
2-21-013	Probe Basket **(14)**	4-100
2-30-398	1/4" Ball Valve for Water Column **(15)**	4-100

*For 4 HP boilers only, the water column probes are 2" shorter.



Parts

Warranty

6

5 Year (60 Month) Conditional Warranty*

On the Fulton Boiler Pressure Vessel

*Fulton Boiler Works, Inc. will repair or replace F.O.B. factory any Fulton pressure vessel which, within FIVE (5) years of the date of shipment from factory, is found to be defective in workmanship or material, provided this equipment is installed, operated and maintained by the buyer in accordance with the Fulton instruction manual and approved practices, and that the +water quality used in the system has been regularly checked to meet the standards for ideal and proper boiler feedwater during the warranty period. ++This warranty does not cover damage or failure that can be attributed to corrosion, (including oxygen pitting) scale or dirt accumulations, or to low water conditions. Follow feedwater specifications and recommended treatment specifications as detailed in Section 1 of the instruction manual shipped with your boiler as well as maintenance procedures as listed in Section 5. This 5 year warranty applies only in the continental U.S.A. and Canada. The Warranty does not include labor charges of any kind. In the event a failure is reported, Fulton will require an analysis of the boiler feedwater to determine that acceptable water conditions are present at the installation site as well as documentation on the feedwater treatment employed since the installation of the boiler. The boiler will be required to be shipped freight prepaid to the Fulton factory for inspection after a failure is reported. The customer may witness the inspection and verification at the factory.

+Consult Fulton Boiler Works, Inc. for analysis of acceptable water conditions.

++Feedwater treatment and proper daily blowdown procedures are very important in keeping your boiler heating surfaces free of scale formation, pitting, oxygen corrosion and foaming or bouncing water. Professional feedwater treatment consultants should be contacted when the boiler is installed. They will recommend the proper treatment required for prolonging boiler life. A thorough boiler inspection should take place during the first six months of operation to assess the effectiveness of boiler water treatment techniques, including analysis of potential oxygen pitting.

It is the owner's responsibility to assure safe operation of the boiler. To avoid corrosion, scale or dirt accumulations, it is recommended that a daily blow down procedure be instituted. The boiler power should be left on during daily blow down so that correct operation in the low water relay may be checked. While blowing down the boiler, the pressure will drop significantly. While blowing boiler down with power on, it is normal to hear the boiler feed pump come on. The burner should not turn on. If the burner does come on, turn the boiler off and contact your local service representative or our factory immediately. Detailed blow down procedures are in the boiler instruction manual shipped with your boiler.

Corrosive acid and chlorine based chemicals in the atmosphere can be damaging to this boiler. It is the owner's responsibility to have the boiler room periodically tested to assure these damaging chemicals are not present.

1 Year (12 Month) Standard Warranty

A

Fulton Boiler Works, Inc. will repair or replace F.O.B. factory any other part of this equipment of our manufacture which within twelve months of the date of shipment from factory is found to be defective in workmanship or material, provided the equipment has been installed, commissioned, operated and maintained by the buyer in accordance with the operating instruction manual provided with the equipment and generally accepted approved practices, and on the provision that the buyer gives proper notification in writing as soon as the defect becomes apparent, and that he has properly filled out and returned his warranty card. This warranty does not include labor charges of any kind. Follow maintenance instructions as listed in the "Instruction Book."

This warranty is exclusive and in lieu of all other warranties, express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Fulton Boiler Works, Inc. shall in no event be liable for an consequential or incidental damages arising in any way, including but not limited to any loss of profits or loss of business, even if Fulton Boiler Works, Inc. has been advised of the possibility of such damages.

B

Controls, motors, feed water pumps, auxiliaries, accessories, and parts manufactured by others may be warrantied by them, but Fulton Boiler Works, Inc. does not provide any warranty for parts manufactured by others. We endeavor to use nationally known controls of the highest quality and most of the manufacturers of these controls maintain exchange or repair offices in the principal cities in the United States and foreign countries, expressly for the exchange, service, and repair of their products. Therefore, we request that our distributors and owners of our Fulton Boilers utilize the nearest offices of the individual manufacturers, for the exchange, service, and/or repair of these defective items. We will be glad to furnish the address of

If it is more convenient for our distributors or owners of our Fulton Boilers, the effective item may be returned to our factory. The manufacturer's sole judgement shall determine the extent of allowance for or replacement of such parts claimed defective.

C

Please do not request the replacement of parts on a no-charge basis that are not within the warranty period. No personnel of Fulton Boiler Works, Inc. has the authorization to grant such a request. We will not honor labor charges of any kind unless authorized in writing by our company.

Component Data Sheets

7

Appendix II

Condenser Specifications

Alfa Laval plate heat exchangers

A product catalogue for comfort heating and cooling

Inside view

4 The Alfa Laval Gasketed Plate Heat Exchanger

6 Heating applications

7 Cooling applications

8 PHE data – tables

10 Accessories

11 Instructions

12 Using webcALc™

14 Radiator heating – tables

15 Tap water heating – tables

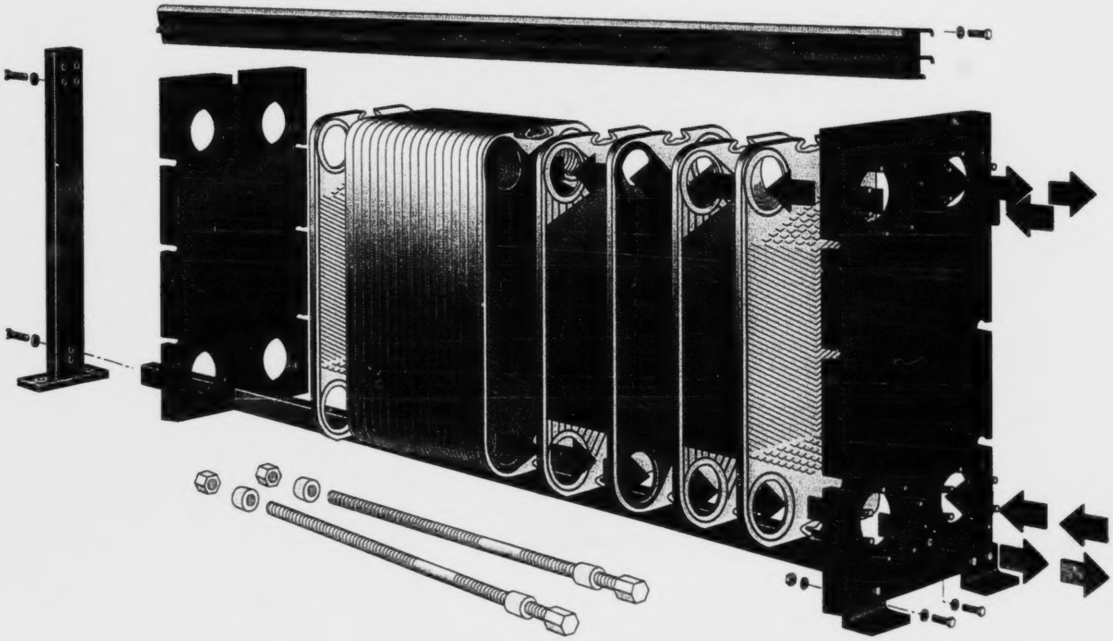
- Single-step pressing of all plates
- Clip-on or glued gaskets
- Quickly and easily opened frames

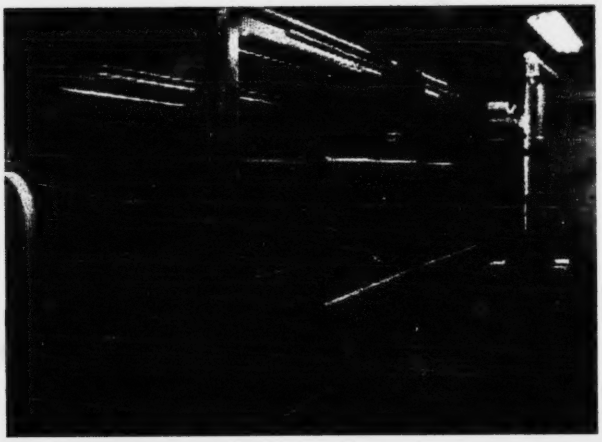
EPDM. Alfa Laval's gaskets are always moulded in one piece. This guarantees exact gasket geometry and no weak links from vulcanisation. Also, the gasket groove on the plate and the gasket itself is designed together to ensure optimum sealing capabilities.

Alfa Laval offers three different gasket fastening solutions, all of which guarantee a perfect result: the revolutionary, quickly inserted Clip-on gasket; the Tape-on gasket for plates with small pressing depths, and glued gaskets with Alfa Laval's specially developed gluing technique for unsurpassable adhesion.

Solid pressure vessel design

The frame is an important component in Alfa Laval's plate heat exchanger (PHE) concept. Thanks to the precision-made and user-friendly frame, the gasketed PHEs can be quickly and easily opened for inspection and gasket replacement. And they are just as easily reassembled with a perfect fit. Time after time. Another advantage of the Alfa Laval frames is that they can easily be adapted for expansion or reconstruction of a PHE. Alfa Laval frames come in many different models, and they can also be customized for different applications.





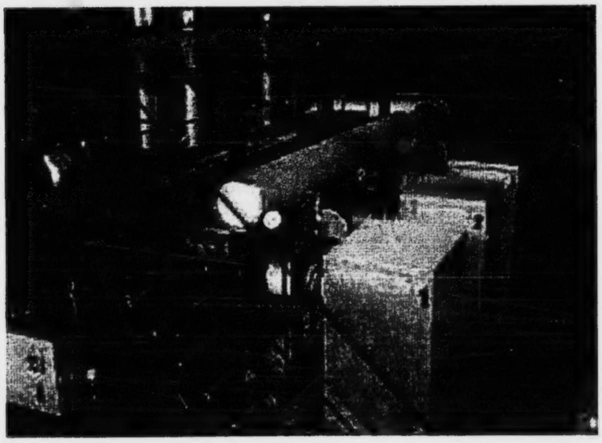


Plate heat exchangers in cooling systems

The requirement for thermal efficiency - close temperatures - is very high particularly in cooling applications lig e.g. thermal storage and free cooling. Thanks to Alfa Laval's superior competence in plate pressing, temperature approaches of down to 0.5°C (0.9°F) between the two circuits can be achieved. In addition, this can be accomplished in a single pass connection with all four connections on the front plate, making installation and maintenance very easy.

Central cooling

The main component of the central comfort cooling system is the cold source, commonly a chiller. While cold water or glycol solution is produced on the evaporator side, heat is generated and rejected on the condenser side of the chiller. There are several benefits using a plate heat exchanger in either the hot condenser circuit or the cold evaporator circuit.

The condenser can for example be cooled by an open cooling source like sea or river water. However, the often aggressive media in the open circuits can affect sensitive A/C equipment such as the chiller. A plate heat exchanger, installed as a divider between the two systems, eliminates these problems. On the cold evaporator side the plate heat exchanger is used to separate two clean cold circuits, and to protect other equipment from high pressures.

District cooling

District cooling is environment-friendly with better utilisation of cooling capacities and an environment-friendly cooling source. It gives the user convenience and comfort and a better level of equipment redundancy, less need for maintenance and space savings. It also gives the user economical benefits with lower investment costs and flexibility of operation. Using plate heat exchangers in indirect district cooling distribution creates a number of advantages, for example pressure interception between the different circuits. The wide range of Alfa Laval PHE models with different characteristics assures that optimum solutions can be found for virtually all comfort cooling duties.

TS6MFG	TS6MFD	M10BFM	M10BFG	M10BFD	M10MFM	M10MFG	M10MFD	M15BFML	M15BFM8	M15BFG8	M15BFD8
704	704	1084	1084	981	1084	1084	981	1815	1885	1885	1980
400	410	470	470	470	470	470	470	650	610	650	650
380	380	719	719	719	719	719	719	1294	1294	1294	1294
203	203	225	225	231	225	225	231	298	298	298	304
-	-	-	-	-	-	-	-	-	-	-	-
70	70	100	100	100	100	100	100	140	140	140	140
20	20	50	50	50	50	50	50	80	80	80	80
180	180	160	160	160	160	160	160	160	160	160	160
16	25	10	16	25	10	16	25	10	10	16	30
Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel

M20MFG	M20MFD	MX20BFMS	MX20BFGS	MX20BFDS	MX25BFM	MX25BFG	MX25BFD	M30FM	M30FG	M30FD
2200	2200	2595	2595	2595	2895	2895	2895	2882	2882	2920
780	780	920	920	940	920	920	940	1150	1170	1190
1478	1478	1939	1939	1939	1939	1939	1939	1842	1842	1842
365	353	439	439	439	439	439	439	596	596	596
-	-	-	-	-	-	-	-	-	-	-
210	210	200/250	200	200	200/250	200/250	200/250	300	300	300
180	180	250	190	190	250	250	250	450	450	450
160	160	160	160	160	160	160	160	140	140	140
30	30	10	16	25	10	16	25	10	16	25
Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel

Plate, gasket and connection materials

Plates can be obtained in all pressable materials. The most common materials are: stainless steel AISI 304, AISI 316, and titanium. Gaskets are available in a wide range of elastomers. The most common are: nitrile and EPDM. Threaded pipe connections are available in stainless steel and titanium, and for M6 also in carbon steel. Flange connections are available unlined or with linings in rubber, stainless steel, titanium or other alloys depending on model.

Max pressure and temperature

All models are available with different frame designs and different plate thickness depending on the required design pressure. The maximum temperature depends on the gasket material used, and the working pressure.

Approvals

All models are approved according to all major pressure vessel codes, including marine classifications.

Start up procedure

1. Before starting any pump, check whether instructions exist stating which pump should be started first.
2. Check that the valve between the pump and the heat exchanger is closed.
3. Check that the valve at the exit, if there is one, is fully open.
4. Open the ventilation.
5. Start the pump.
6. Open the valve slowly.
7. When all the air is out, close the ventilation.
8. Repeat the procedure for the other side.

Shut down procedure

1. First establish whether instructions exist as to which side should be stopped first.
2. Slowly close the valve controlling the flow rate of the pump you are about to stop.
3. When the valve is closed, stop the pump.
4. Repeat the procedure for the other side.
5. If the heat exchanger for any reason is shut down for a longer period, more than a few days, it should be drained.

Installation instructions

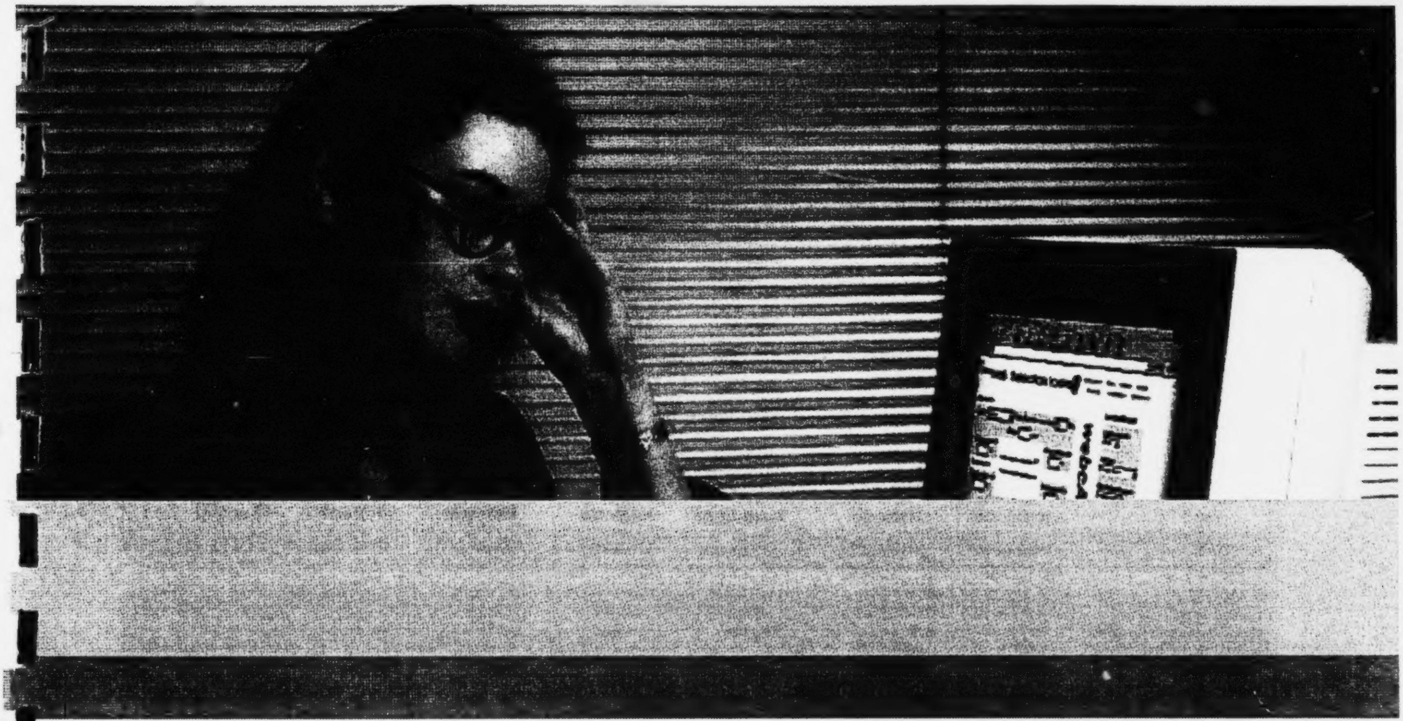
In HVAC applications, it is recommended, from a performance point of view, to install the heat exchanger so that a counter current flow is obtained. Alfa Laval recommends installing the PHE on a flat foundation giving the necessary support to the frame. It is important to leave free space around the PHE, to be able to carry out maintenance work if needed. Make sure that all foreign objects have been rinsed out of the system before connecting any piping to the heat exchanger. Also, no stress or strain is to be placed on the PHE by the piping system.

Operation

Adjustments in flow rates to maintain correct temperatures or pressure drops should be made slowly in order to prevent pressure shocks to the system. Any problems in maintaining the performance of the heat exchanger may be caused by changing temperature conditions, changing flow rates or by fouling. As long as the PHE is operating satisfactorily, it should be left without any interference. After start-up, the PHE does not require continuous supervision.

Maintenance instructions

The heat transfer through the plates can be seriously reduced by the formation of deposits of various kinds on the plate surfaces. Even if the highly turbulent flow gives a strong resistance to the formation of deposits the turbulence can not completely eliminate fouling. Normal maintenance does not usually require the PHE to be opened (apart from occasional check of plates and gaskets). Thanks to CIP (Cleaning In Place) it is possible to remove calcium deposits and other forms of scaling from the plate surfaces in an easy and effective way without opening the heat exchanger. Different cleaning solutions can be used depending on the type of deposits. Alfa Laval has a worldwide service organisation. Service is available in 130 countries at 15 major service centres and a network of service stations around the globe.



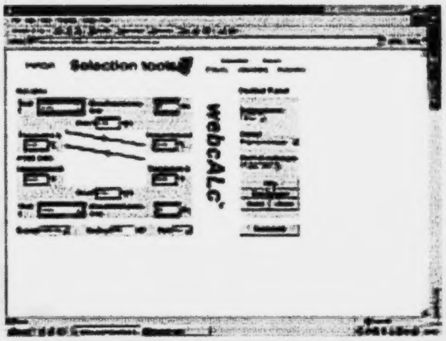
Press calculate to perform the thermal calculation. webcALc™ will present up to nine alternative heat exchanger solutions. It is possible to use the calculate button without previous usage of heat balance. Press reset to empty your input before entering new data for a new thermal calculation. The input fields will be reset to webcALc™'s default values.

How to use and interpret webcALc™'s results

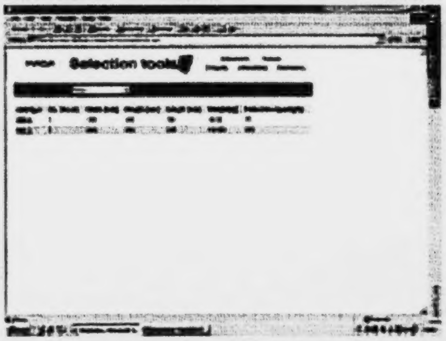
The heat exchanger solutions can be sorted by four different criteria: price (default sorting is based on an approximate price comparison between the different solutions), height, weight, and extension capacity. Brazed heat exchangers do not offer any extension possibility. Please note that the specified weights may be slightly lower due to different pressure vessel codes and local standards. Select your solution by clicking on the unit type in the table.

The output of webcALc™

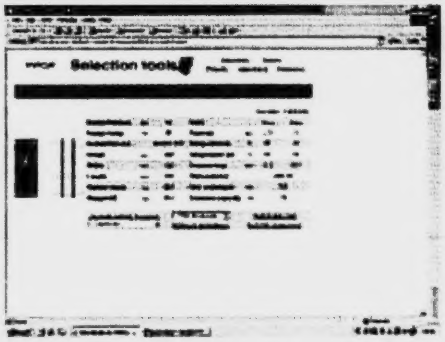
Each solution is presented with a standardised drawing and the specific technical parameters. Each solution also has a corresponding AutoCAD drawing, which can be downloaded to your computer. To print the technical parameters, use the printer-friendly page offered at the bottom of the result page. It is also possible to download specification texts for different types of heat exchangers.



webcALc™ selects from the complete range of gasketed and brazed heat exchangers included in the software (default).



Press calculate to perform the thermal calculation. webcALc™ will present up to nine alternative heat exchanger solutions.



Each solution is presented with a standardised drawing and the specific technical parameters.

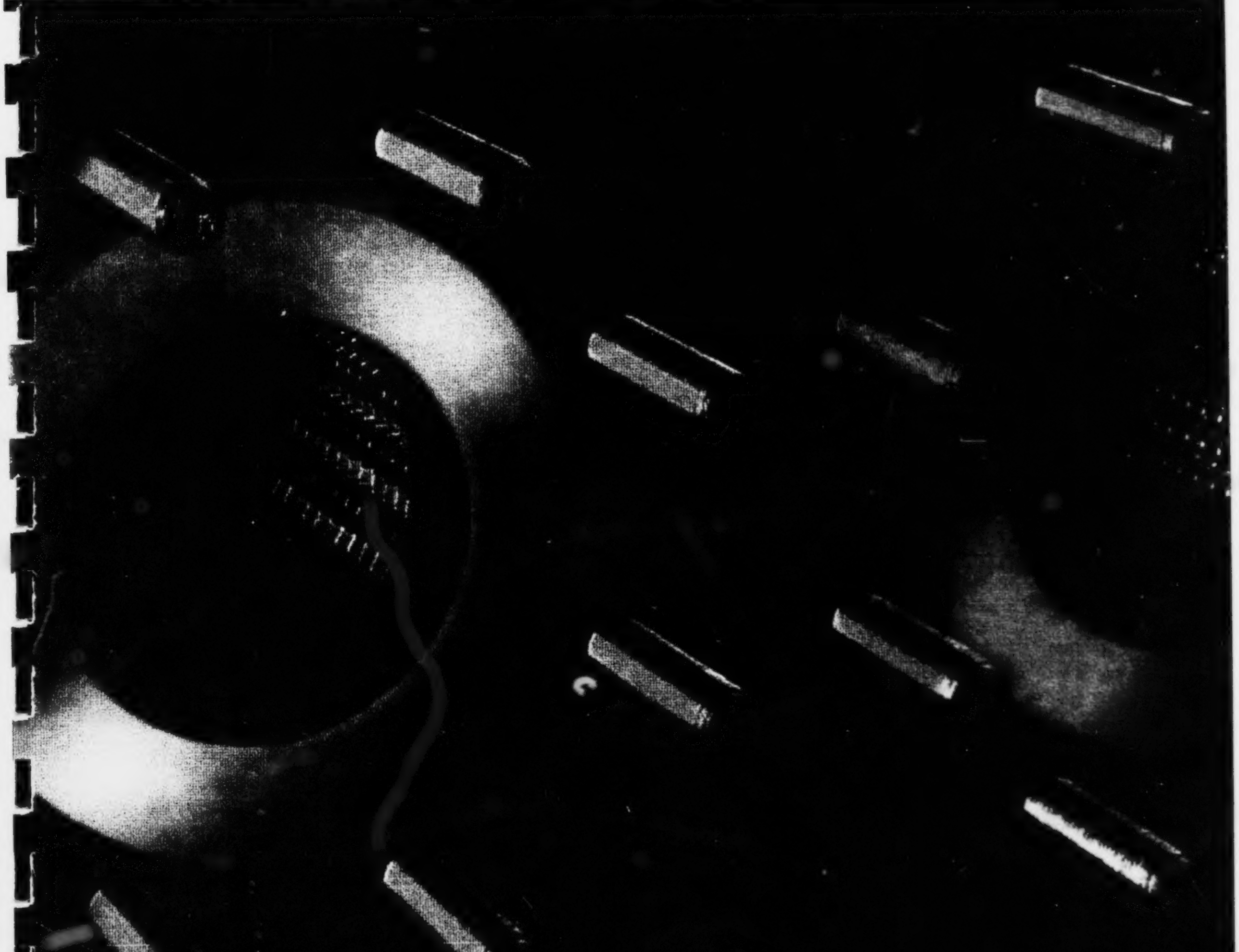
Prim.in→out/out←Sec.in Max pressure drop prim/sec	90→70/60←10 20/20 kPa	90→70/55←10 20/30 kPa	90→70/55←10 30/30 kPa	90→70/50←10 30/30 kPa	90→60/60←30 30/30 kPa	80→60/55←10 30/30 kPa	80→50/60←10 20/20 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-14M	M3-14M	M3-12M	M3-12M	M3-12H	M3-14M	M3-14M
100	M3-24M	M3-24M	M3-20M	M3-20M	M3-20H	M3-24M	M3-24M
150	M3-36M	M3-36M	M3-28M	M3-28M	M3-30H	M3-32M	M3-36M
200	M6M-14L	M6M-14L	M3-40M	M3-40M	M3-40H	M3-42M	M3-50M
300	M6M-18L	M6M-18L	M6M-16L	M6M-16L	M3-62H	M6M-20L	M6M-20M
400	M6M-24L	M6M-24L	M6M-20L	M6M-20L	M6M-20M	M6M-23L	M6M-26M
500	M6M-30L	M6M-30L	M6M-24L	M6M-24L	M6M-24M	M6M-30L	M6M-30M
750	M10M-26M	M10M-22L	M10M-22M	M10M-18L	M6M-36M	M10M-24M	M6M-46M
1,000	M10M-36M	M10M-28L	M10M-30M	M10M-24L	M6M-50M	M10M-30M	M10M-40H

Prim.in→out/out←Sec.in Max pressure drop prim/sec	70→50/60←10 20/20 kPa	70→50/55←10 20/30 kPa	70→40/55←5 30/30 kPa	70→35/55←10 20/20 kPa	70→35/55←10 30/30 kPa	70→35/55←5 20/20 kPa	70→35/55←5 30/30 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-22H	M3-20H	M3-22H	M3-34H	M3-34H	M3-30H	M3-30H
100	M3-38H	M3-36H	M3-40H	M3-62H	M3-62H	M3-54H	M3-54H
150	M3-56H	M3-56H	M3-58H	M3-90H	M3-90H	M3-78H	M3-74H
200	M6M-22M	M6M-18M	M3-76H	M6M-18H	M6M-18H	M6M-18H	M6M-18H
300	M6M-30M	M6M-26M	M6-22M	M6M-26H	M6M-26H	M6M-26H	M6M-22H
400	M6M-40M	M6M-36M	M6-28M	M6M-34H	M6M-32H	M6M-34H	M6M-28H
500	M6M-48M	M6M-46M	M6-36M	M6M-42H	M6M-40H	M6M-42H	M6M-36H
750	M10M-44H	M10M-44H	M6-54M	M6M-66H	M6M-56H	M6M-66H	M6M-52H
1,000	M10M-60H	M10M-60H	M6-76M	M6M-92H	M6M-74H	M6M-92H	M6M-72H

Prim.in→out/out←Sec.in Max pressure drop prim/sec	70→30/60←5 50/50 kPa	70→25/60←10 20/20 kPa	60→20/55←10 20/25 kPa	60→30/55←25 30/30 kPa	60→25/55←5 20/20 kPa	60→25/55←5 30/30 kPa	6→20/55←10 20/25 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M6-10H	M6-14H	M6-18H	M6-42H	M6-14H	M6-14H	M6-32H
100	M6-14H	M6-20H	M6-32H	M6-78H	M6-24H	M6-24H	M6-58H
150	M6-16H	M6-28H	M6-44H	M6-114H	M6-34H	M6-34H	M6-84H
200	M6-20H	M6-36H	M6-56H	M6-150H	M6-42H	M6-42H	M6-110H
300	M6-28H	M6-52H	M6-82H	M10B-268H	M6-60H	M6-60H	M6-164H
400	M6-36H	M6-66H	M6-108H	M10B-354H	M6-78H	M6-78H	M10B-256H
500	M6-44H	M6-82H	M6-132H	M10B-440H	M6-96H	M6-96H	M10B-320H
750	M6-64H	M6-120H	M6-196H	-	M10B-136H	M10B-136H	-
1,000	M6-82H	M10B-148H	M10B-274H	-	M10B-178H	M10B-178H	-

Alfa Laval plate heat exchangers

A product catalogue for HVAC



Inside view

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12 Radiator heating specifications
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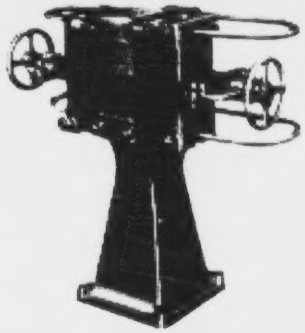
Six sound reasons to buy your PHEs from the market leader



Alfa Laval supplied the first plate heat exchangers to the dairy industry in 1931. Plates were 5-10 mm thick with a milled pattern, compared with 0.4 mm today. In developing our range of plate heat exchangers, we have focused on cost-efficiency.

1. Technology that saves you money
The result of decades of development and testing, Alfa Laval plate heat exchangers utilise well-proven materials and advanced designs that optimize performance. Most important of all, they reduce your operating costs and save you money.

2. Service-friendly designs
Service-friendly designs ensure that even the largest Alfa Laval PHE can be serviced rapidly and easily by one person using standard tools. This reduces downtime, enhances safety and ensures a longer equipment life-time.

3. A wide range of solutions
Let us advise you on the correct solutions for your specific needs. Alfa Laval PHEs come in a wide range of sizes and capacities. Different plate patterns are available for various duties and performance specifications. A range of pressing depths from 1.5 mm to 11 mm ensures an optimal plate design for any duty. Two-pass plate packs can give double capacity in the same floor space.

4. Full compliance with PED
All Alfa Laval PHEs comply with the European Pressure Vessel Safety Directive, PED, in terms of mechanical and materials specifications. They can also be delivered according to other relevant standards, such as ASME. Various national codes are also available.

5. A partner you can trust
Genuine application know-how and long experience make Alfa Laval the ideal business partner for heating and cooling. Rely on us to supply the most cost-effective solution for your specific needs – we won't let you down.

6. Fast deliveries and service worldwide
Alfa Laval is a truly global company. Our regional distribution centres serve Alfa Laval facilities and distributors worldwide, ensuring fast delivery to customers. We also have more than 30 Alfa Laval PHE Service Centres throughout the world. Wherever you are, talk to us, we're only a phone call away.

Choosing Alfa Laval makes sound financial sense

Alfa Laval gasketed heat exchangers

Alfa Laval plate heat exchangers (PHEs) are the most cost-efficient solution available for your comfort heating and cooling needs. The result of decades of development and testing, our PHEs utilise well-proven materials and advanced designs that optimise performance and reduce your operating costs. We are the market leader. Our cost-efficient products and unmatched global distribution and service capabilities make us the ideal business partner.

- **Single-step pressing of plates down to 0.4 mm**
- **Unique plate patterns for optimal heat exchange**
- **Clip-on or glued gaskets**

Reliability in a single step

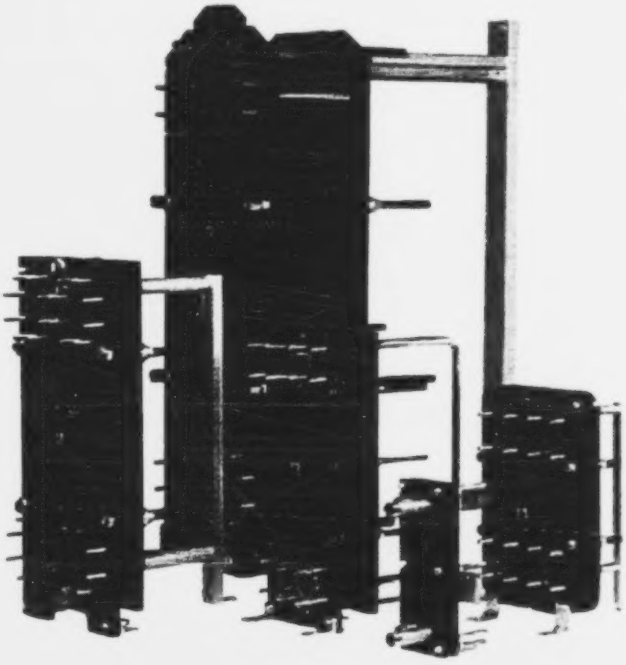
The heat transfer efficiency and degree of process control offered by a PHE depend partly on the thickness of the plates. In today's advanced Alfa Laval units, plates as thin as 0.4 mm, normally in stainless steel, offer highly efficient heat transfer and impressive strength.

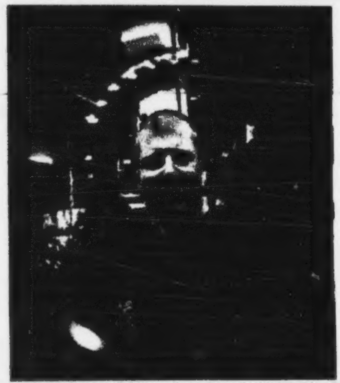
Each plate is pressed in a single step in a hydraulic press exerting a pressure of up to 40,000 tons. Thus all plates are identical, minimising the risk of distortion and leakage when hundreds are stacked together in a PHE. When assembled with gaskets, the metal-to-metal contact points on the plates create a flexible, yet mechanically stable construction that can withstand enormous stress.

The pattern of performance

The corrugated pattern on the plates gives parallel flow and strength. The "chocolate" pattern of the distribution area ensures even distribution of the fluid over the plate surface, while the herringbone pattern in the main heat transfer area creates maximum turbulence. Together, these features ensure high heat transfer efficiency and eliminate dead spots that can lead to scaling and corrosion.

With parallel flow, only one plate type and one gasket type are required in the heat exchanger. This means fewer spare parts and simpler installation and maintenance. As the plate corrugations are fully supported diagonally across the entire surface, a higher design pressure can be achieved, or plates can be made thinner.





- **Wide range of products for every need**
- **Extremely reliable**
- **Highly service-friendly**

The seal of approval

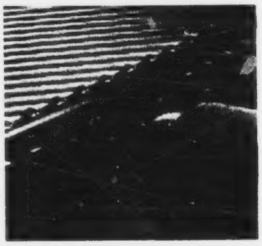
Our ongoing development and testing of gasket materials for specific duties, ensure that Alfa Laval gaskets last longer. Made from nitrile (NBR) or EPDM, they are moulded in one piece, guaranteeing exact gasket geometry. Our "roof-top" gasket profile produces a highly efficient seal, minimising the risk of leakage.

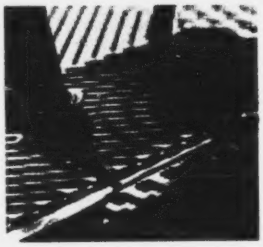
The groove on the plate and the gasket are a perfect match, ensuring full support for the gasket and eliminating the risk of a gasket blow-out. The gasket groove design ensures minimum contact between the media and the gasket, another factor that makes our gaskets last longer.

Bonded for life

Alfa Laval gasket fastening solutions guarantee a perfect result. The Alfa Laval glue-free clip-on gasket makes re-gasketing fast and simple.

Where the PHE is opened frequently, glued gaskets are an excellent solution. Alfa Laval uses two-component, oven-cured epoxy glue to bond the gasket to the plate. This more than doubles gasket life-time compared to using standard rubber glues.



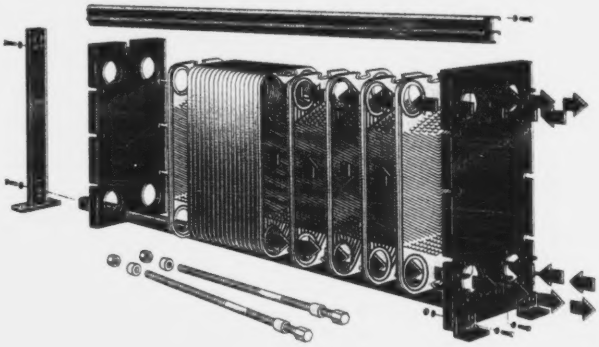


Designed with service in mind

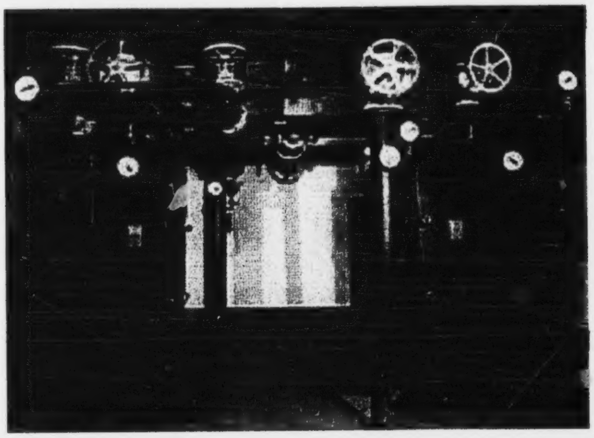
Alfa Laval gasketed PHEs of all sizes can be opened quickly and easily for inspection and gasket replacement by one man using standard tools. They are reassembled just as easily.

Our large units feature Alfa Laval's 5-point alignment system. Precise positioning of the plates horizontally and vertically ensures efficient sealing throughout the plate pack. A roller on the pressure plate, and bearing boxes on the four tightening bolts, make opening and closing an easy task.

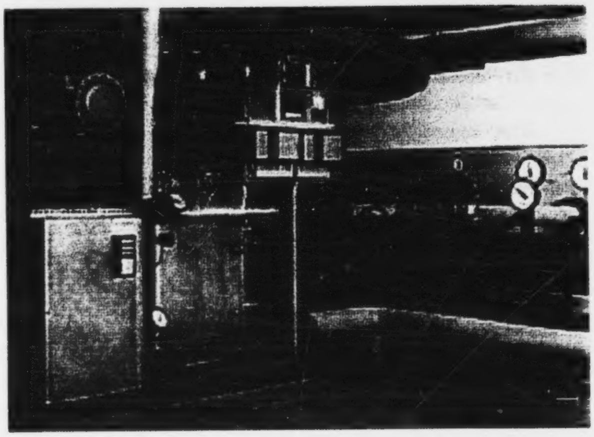
Simpler in design, our smaller PHEs are equally service-friendly, while keeping costs to a minimum. During reassembly, alignment of the plate pack is achieved using the round carrying and guide bar. Corner guides lock the plates in position and ensure perfect final alignment.



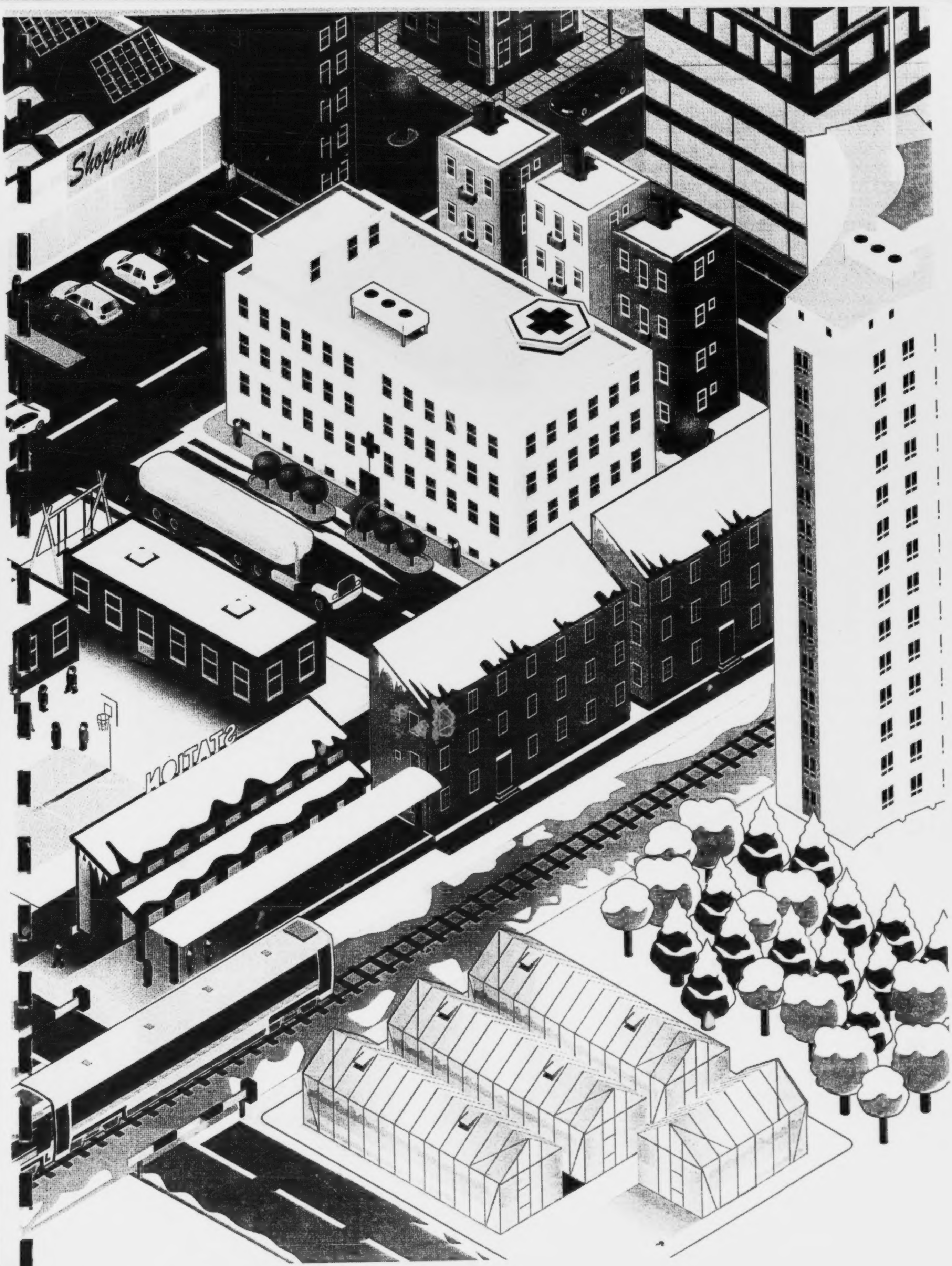
PHEs in heating systems
Plate heat exchangers are commonly used in all types of heating applications with demands on comfort, reliability and safety. In addition to transferring heat from one circuit to another, the heat exchanger also efficiently handles the pressure differences that normally exist between the primary and secondary sides. The Alfa Laval range of gasketed plate heat exchanger models covers all comfort heating duties like tap water heating and swimming pool heating, from small to large capacities. Thanks to a flexible design, the PHE can be tailor-made to fit your specific needs exactly.



Tap water heating
The advantages of using a plate heat exchanger to produce hot tap water compared to traditional coil in tank systems are numerous. The PHE instantly heats the tap water to the required temperature when it passes through the heat exchanger. This means that hot water is available immediately and at any time. Another benefit with using plate heat exchangers for hot tap water production is that the system requires much less space than a traditional tank and coil system. If solar energy is used to produce hot tap water, a PHE makes it possible to separate the treated water in the solar panels from the tap water circuit. Also, scaling problems and corrosion risks in the solar panels are reduced when separating the circuits with a PHE.



Swimming pool heating
During the summer season when the building's heating system is not used to full capacity, excess heat from the existing heat source can be used for heating outdoor pools. A heat exchanger installed between the swimming pool's circulation system and the building's ordinary heating system separates the circuits and provides pool heating. It's important to remember that addition of chlorine should take place after the water has passed the heat exchanger in order to avoid a high concentration of chlorine flowing through the heat exchanger. It is recommended to use titanium plates when the chloride concentration is high.


Shopping
STATION

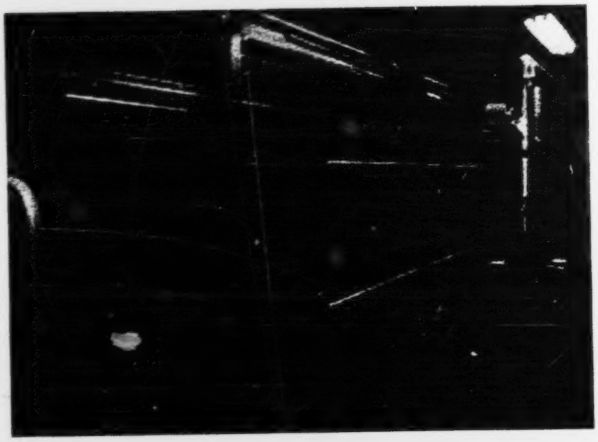
PHEs in cooling systems

The requirement for thermal efficiency - close temperatures - is very high particularly in cooling applications e.g. thermal storage and free cooling. Thanks to Alfa Laval's superior competence in plate pressing, temperature approaches of down to 0.5°C (0.9°F) between the two circuits can be achieved. In addition, this can be accomplished in a single pass connection with all four connections on the front plate, making installation and maintenance very easy.

Central cooling

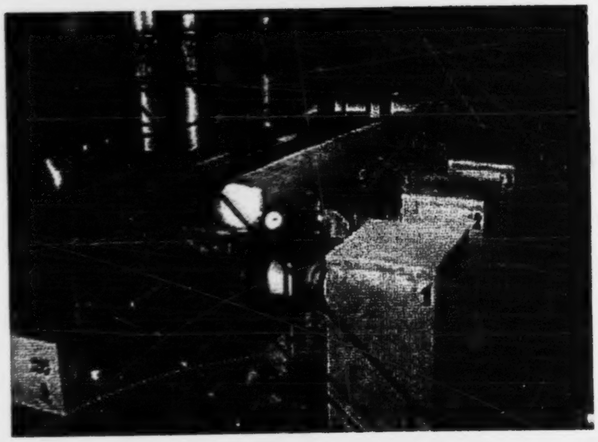
The main component of the central comfort cooling system is the cold source, commonly a chiller. While cold water or glycol solution is produced on the evaporator side, heat is generated and rejected on the condenser side of the chiller. There are several benefits using a plate heat exchanger in either the hot condenser circuit or the cold evaporator circuit.

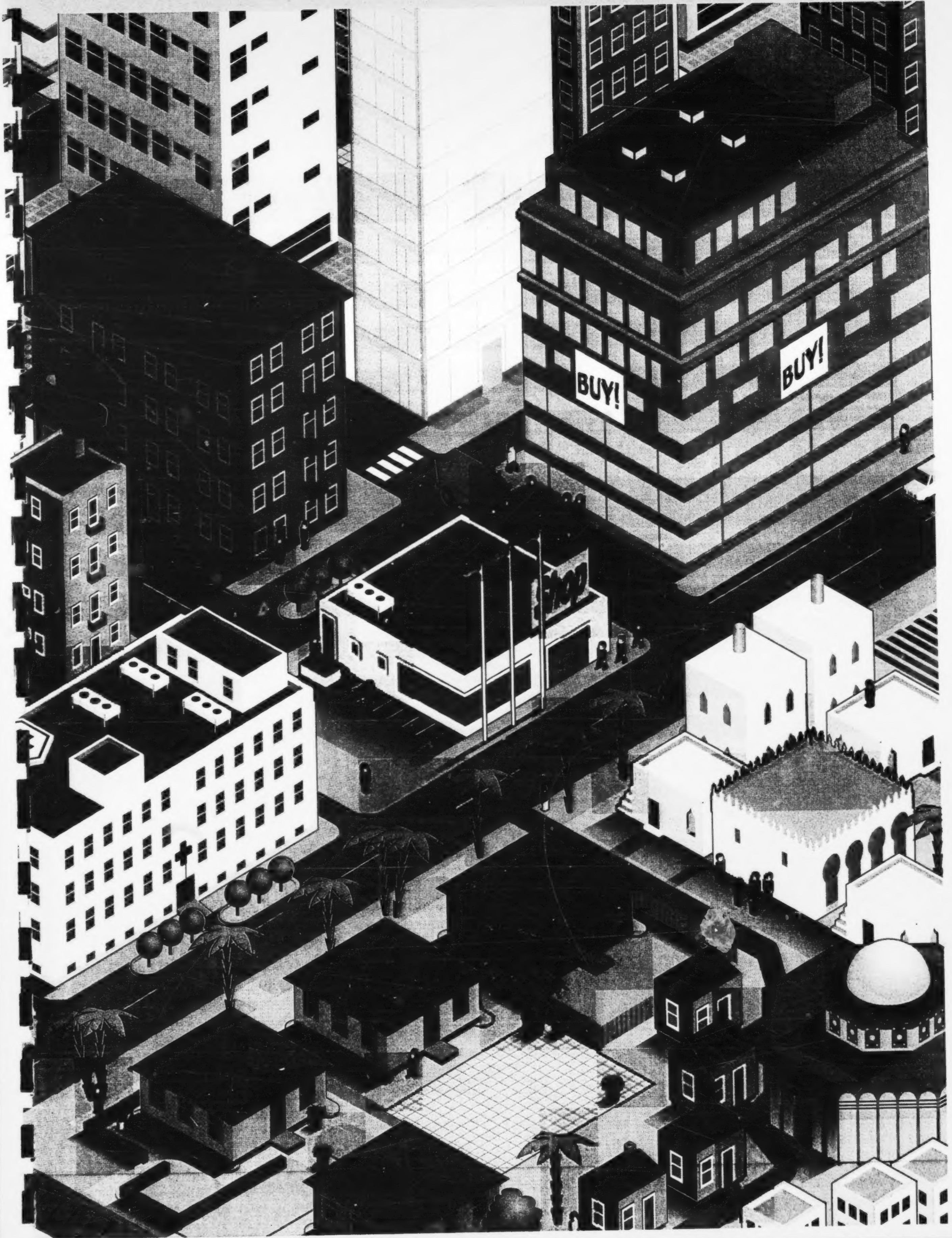
The condenser can for example be cooled by an open cooling source like sea or river water. However, the often aggressive media in the open circuits can affect sensitive AC equipment such as the chiller. A plate heat exchanger, installed as a divider between the two systems, eliminates these problems. On the cold evaporator side the plate heat exchanger is used to separate two clean cold circuits, and to protect other equipment from high pressures.



District cooling

District cooling is environment-friendly with better utilisation of cooling capacities and an environment-friendly cooling source. It gives the user convenience and comfort and a better level of equipment redundancy, less need for maintenance and space savings. It also gives the user economical benefits with lower investment costs and flexibility of operation. Using plate heat exchangers in indirect district cooling distribution creates a number of advantages, for example pressure interception between the different circuits. The wide range of Alfa Laval PHE models with different characteristics assures that optimum solutions can be found for virtually all comfort cooling duties.

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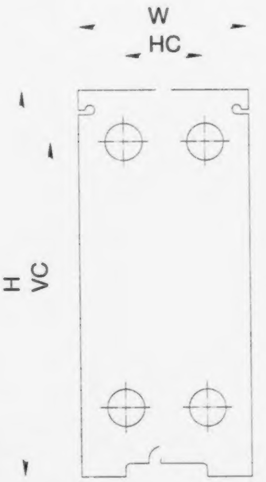
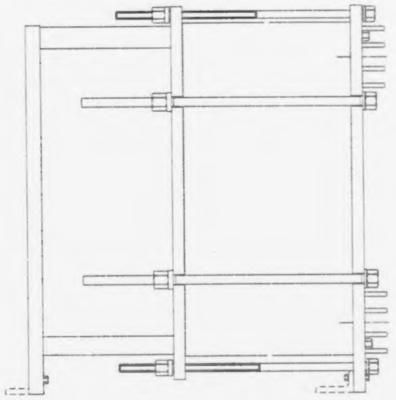
Shop

Model, frame	M3FG	M3FGL	M6FM, FML	M6FG, FGL	M6FD	M6MFM, FML	M6MFG, FGL	M6MFD	TS6MF
Height, H, (mm)	480	480	920	920	940	920	920	940	704
Width, W, (mm)	180	180	320	320	330	320	320	330	400
Vertical connection dist., VC, (mm)	357	357	640	640	640	640	640	640	380
Horizontal connection dist., HC, (mm)	60	60	140	140	140	140	140	140	203
Connection size, pipe (inch)	1¼"	1¼"	2"	2"	-	2"	2"	-	-
Connection size, flange (mm)	-	-	60	60	60	60	60	60	70
Max flow rate, (kg/s)	3.9	3.9	15	15	15	15	15	15	20
Max temperature, (°C)	140	140	160	160	160	160	160	160	180
Max pressure, (barg)	10	10	10	16	25	10	16	25	16
Flow principle	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parall

Model, frame	M15MFM8	M15MFG8	M15MFD8	M15EFG8	M15EFD8	TS20MFM	TS20MFG	TS20MFS
Height, H, (mm)	1885	1885	1980	1885	1980	1405	1405	1435
Width, W, (mm)	610	650	650	650	650	740	800	800
Vertical connection dist., VC, (mm)	1294	1294	1294	1294	1294	698	698	698
Horizontal connection dist., HC, (mm)	298	298	304	298	304	363	363	363
Connection size, pipe (inch)	-	-	-	-	-	-	-	-
Connection size, flange (mm)	140	140	140	140	140	200	200	200
Max flow rate, (kg/s)	80	80	80	65	65	190	190	190
Max temperature, (°C)	160	160	160	60	60	180	180	180
Max pressure, (barg)	10	16	30	16	30	10	16	30
Flow principle	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel





TS6MFD	M10BFM	M10BFG	M10BFD	M10MFM	M10MFG	M10MFD	M15BFML	M15BFM8	M15BFG8	M15BFD8
704	1084	1084	981	1084	1084	981	1815	1885	1885	1980
410	470	470	470	470	470	470	650	610	650	650
380	719	719	719	719	719	719	1294	1294	1294	1294
203	225	225	231	225	225	231	298	298	298	304
-	-	-	-	-	-	-	-	-	-	-
70	100	100	100	100	100	100	140	140	140	140
20	50	50	50	50	50	50	80	80	80	80
180	160	160	160	160	160	160	160	160	160	160
25	10	16	25	10	16	25	10	10	16	30
Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel

T20MFG	T20MFS	MX25BFMS	MX25BFGS	MX25BFDS	MX25BFG	MX25BFD	M30FM	M30FG	M30FD
2200	2200	2595	2595	2595	2895	2895	2882	2882	2920
780	780	920	920	940	920	940	1150	1170	1190
1478	1478	1939	1939	1939	1939	1939	1842	1842	1842
365	353	439	439	439	439	439	596	596	596
-	-	-	-	-	-	-	-	-	-
210	210	200/250	200	200	200/250	200/250	300	300	300
180	180	250	190	190	250	250	450	450	450
160	160	160	160	160	160	160	140	140	140
30	30	10	16	25	16	25	10	16	25
Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel

Plate, gasket and connection materials

Plates can be obtained in all pressable materials. The most common materials are: stainless steel AISI 304, AISI 316, and titanium. Gaskets are available in a wide range of elastomers. The most common are: nitrile and EPDM. Threaded pipe connections are available in stainless steel and titanium, and for M6 also in carbon steel. Flange connections are available unlined or with linings in rubber, stainless steel, titanium or other alloys depending on model.

Maximum pressure and temperature

All models are available with different frame designs and different plate thickness depending on the required design pressure. The maximum temperature depends on the gasket material used, and the working pressure.

Approvals

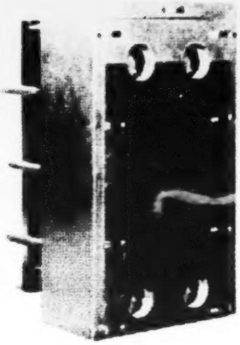
All models are approved according to all major pressure vessel codes, including marine classifications.

Insulation

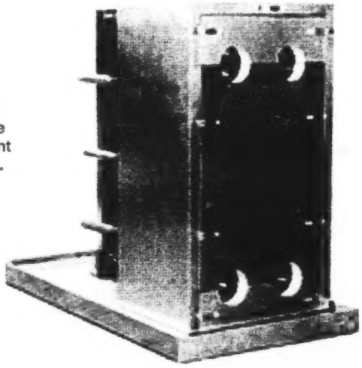
Insulation, designed for HVAC applications, is available for most PHE models. There are two different types of insulation – heating and cooling insulation.

The reason for having two different types is that the mineral wool will be wet from condensing water if used when the heat exchanger temperature is lower than the surrounding temperature. Polyurethane is more expensive than mineral wool, but technically the cooling insulation can be used for heating duties as well.

Heating insulation
Heating insulation consists of 65 mm of mineral wool, cladded with a 1 mm aluminium sheet on the outside and aluminium foil on the inside. It covers all sides of the PHE including the frame and pressure plate, except downwards. The different parts are held together with snap catches.



Cooling insulation
Cooling insulation consists of 60 mm of polyurethane, cladded with a 1 mm aluminium sheet on the outside and aluminium foil on the inside. It covers all sides of the PHE including the frame- and pressure plate, except down-wards, where there is a galvanized drip tray. The different parts are held together with snap catches.

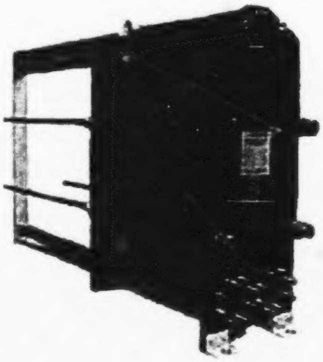


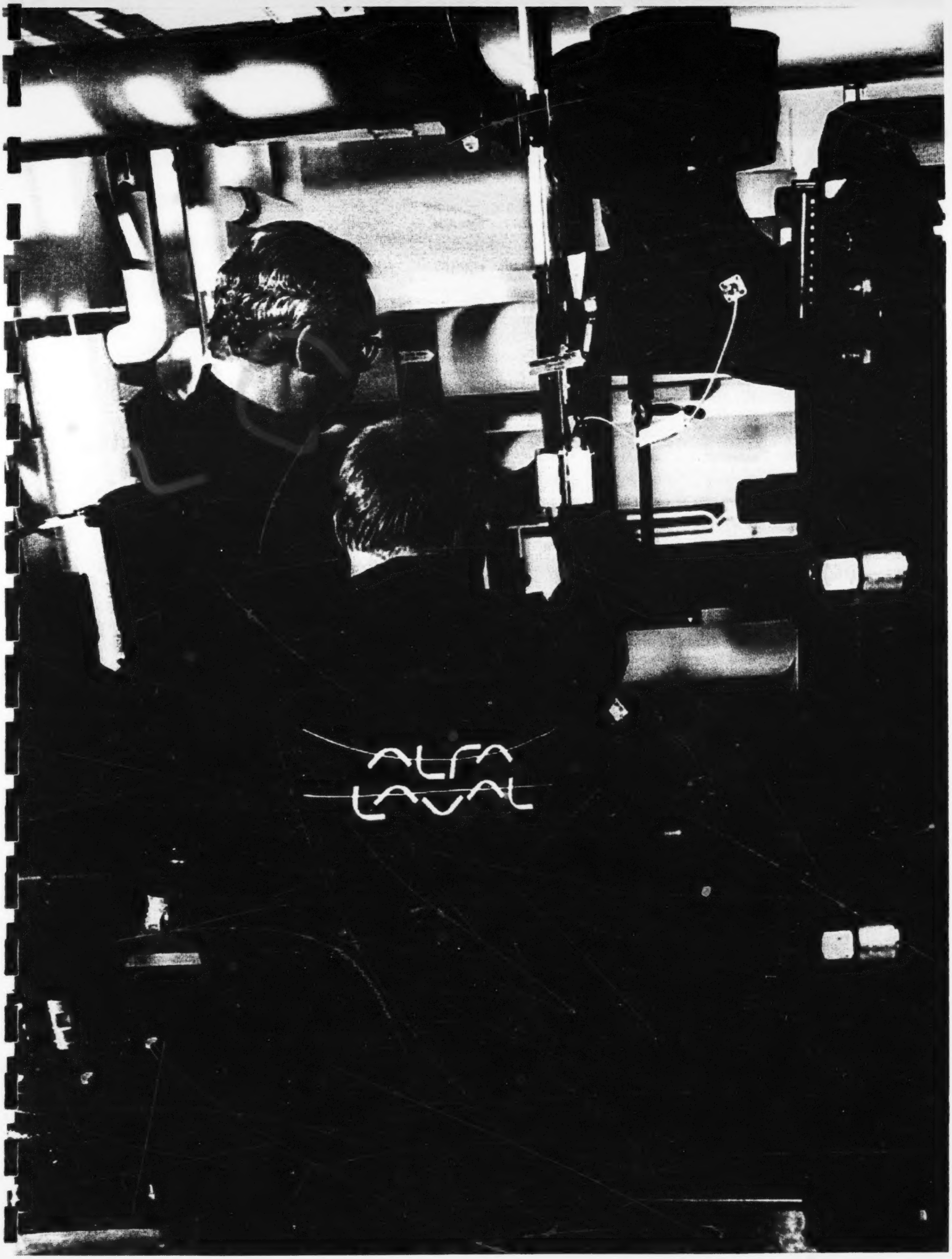
Drip tray

The Alfa Laval drip tray insulates the heat exchanger from the floor, and it also collects any condensate formed on the outside of the heat exchanger. The drip tray also collects any remaining water (after drainage) in the PHE when the unit is opened for inspection or maintenance. The drip tray consists of 0.75 mm hot galvanized steel plates, 50 mm polyurethane foam, supports of waterproof wood, and a draining valve.

Protection sheet

A protection sheet is a device covering all sides of the plate pack except downwards. It is used to prevent persons from getting injured if a sudden leak of hot, corrosive or toxic media should occur. The Alfa Laval protection sheet consists of one or more aluminium or stainless steel (AISI 304) sheet(s) formed to fit the PHE. On most frames the sheet is fitted between the plate pack and the tightening bolts.

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Prim.in→out/out←Sec.in Max pressure drop prim/sec	160→80/90←70 50/20 kPa	135→70/70←55 20/20 kPa	35→80/95←70 10/20 kPa	135→80/95←70 20/30 kPa	135→80/90←70 10/20 kPa	135→80/90←70 20/30 kPa	130→80/95←70 10/20 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-18H	M3-14M	M3-18H	M3-18H	M3-18H	M3-14H	M3-20H
100	M3-34H	M3-30M	M3-30H	M3-30H	M3-34H	M3-24H	M3-34H
150	M6M-12M	M6M-12L	M3-42H	M3-42H	M3-54H	M3-42H	M3-48H
200	M6M-16M	M6M-16L	M3-58H	M3-56H	M6M-16M	M3-60H	M3-62H
300	M6M-24M	M6M-22L	M6M-24M	M6M-24M	M6M-24M	M6M-20M	M6M-28M
400	M6M-34M	M6M-32L	M6M-32M	M6M-32M	M6M-34M	M6M-26M	M6M-34M
500	M6M-44M	M10M-22M	M6M-38M	M6M-38M	M6M-44M	M6M-34M	M6M-42M
750	M10M-40M	M10M-34M	M10M-34H	M6M-54M	M10M-42H	M10M-34H	M10M-36H
1,000	M10M-52M	M10M-46M	M10M-46H	M10M-42H	M10M-58H	M10M-46H	M10M-48H

Prim.in→out/out←Sec.in Max pressure drop prim/sec	130→80/95←70 20/30 kPa	130→80/9←70 10/20 kPa	30→80/90←70 20/30 kPa	135→75/95←70 50/20 kPa	135→75/90←70 50/20 kPa	130→70/85←65 50/20 kPa	10→70/80←65 30/30 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-20H	M3-18H	M3-16H	M3-32H	M3-24H	M3-26H	M3-28H
100	M3-34H	M3-34H	M3-28H	M3-60H	M3-44H	M3-46H	M3-52H
150	M3-48H	M3-54H	M3-42H	M6M-18H	M3-64H	M3-66H	M6M-24M
200	M3-62H	M6M-16M	M3-60H	M6M-22H	M6M-26M	M6M-28M	M6M-30M
300	M6M-28M	M6M-24M	M6M-20M	M6M-34H	M6M-38M	M6M-40M	M6M-42M
400	M6M-34M	M6M-34M	M6M-26M	M6M-46H	M6M-48M	M6M-50M	M10B-26H
500	M6M-42M	M6M-44M	M6M-34M	M6M-58H	M10M-34H	M10M-36H	M10B-32H
750	M10M-36H	M10M-42H	M10M-34H	M10M-68H	M10M-50H	M10M-52H	M10B-50H
1,000	M10M-48H	M10M-58H	M10M-46H	M10M-88H	M10M-64H	M10M-68H	M10B-66H

Prim.in→out/out←Sec.in Max pressure drop prim/sec	110→60/80←55 30/30 kPa	110→60/70←50 30/30 kPa	105→70/85←65 50/30 kPa	95→45/75←40 20/20 kPa	75→40/70←35 10/20 kPa	65→40/60←35 10/30 kPa	60→50/45←35 20/20 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-48H	M3-18H	M3-52H	M6-12H	M6-46H	M6-30H	M3-24H
100	M3-90H	M3-30H	M6M-16H	M6-20H	M6-84H	M6-54H	M6M-14L
150	M6M-20M	M3-44H	M6M-22H	M6-28H	M6-124H	M6-80H	M6M-18L
200	M6M-26M	M3-62H	M6M-28H	M6-34H	M6-162H	M6-104H	M6M-24L
300	M6M-36M	M6M-24M	M6M-40H	M6-50H	M10B-294H	M6-152H	M10M-22M
400	M6M-46H	M6M-32H	M6M-50H	M6-64H	M10B-390H	M10B-208H	M10M-28M
500	M6M-56H	M6M-38H	M10B-64H	M6-78H	-	M10B-258H	M10M-36M
750	M6M-82H	M10M-36H	M10B-86H	M6-114H	-	M10B-382H	M10M-54M
1,000	M10B-68H	M10M-48H	M10B-134H	M10B-132H	-	-	-

Heat exchanger selection tables

The selection tables in this catalogue enable you to find a suitable heat exchanger model and size in a quick and easy way for a number of pre-defined duties. The duties are based on radiator and tap water heating duties which are common in some European countries where district heating is used. It is of course impossible to cover all temperatures and capacities in tables like these, but hopefully they can provide you with some guidance when selecting a heat exchanger for your duty. Of course, you are also most welcome to contact any Alfa Laval representative who will be happy to assist you with a heat exchanger selection.

Disclaimer

While every precaution has been taken, Alfa Laval assumes no responsibility for errors or omissions, or for damages resulting from the use of the information contained herein. We reserve the right to change our products and the specifications detailed in this brochure without prior notice.

Prim.in→out/out←Sec.in Max pressure drop prim/sec	90→70/60←10 20/20 kPa	90→70/55←10 20/30 kPa	90→70/55←10 30/30 kPa	90→70/50←10 30/30 kPa	90→60/60←30 30/30 kPa	80→60/55←10 30/30 kPa	80→50/60←10 20/20 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-14M	M3-14M	M3-12M	M3-12M	M3-12H	M3-14M	M3-14M
100	M3-24M	M3-24M	M3-20M	M3-20M	M3-20H	M3-24M	M3-24M
150	M3-36M	M3-36M	M3-28M	M3-28M	M3-30H	M3-32M	M3-36M
200	M6M-14L	M6M-14L	M3-40M	M3-40M	M3-40H	M3-42M	M3-50M
300	M6M-18L	M6M-18L	M6M-16L	M6M-16L	M3-62H	M6M-20L	M6M-20M
400	M6M-24L	M6M-24L	M6M-20L	M6M-20L	M6M-20M	M6M-23L	M6M-26M
500	M6M-30L	M6M-30L	M6M-24L	M6M-24L	M6M-24M	M6M-30L	M6M-30M
750	M10M-26M	M10M-22L	M10M-22M	M10M-18L	M6M-36M	M10M-24M	M6M-46M
1,000	M10M-36M	M10M-28L	M10M-30M	M10M-24L	M6M-50M	M10M-30M	M10M-40H

Prim.in→out/out←Sec.in Max pressure drop prim/sec	70→50/60←10 20/20 kPa	70→50/55←10 20/30 kPa	70→40/55←5 30/30 kPa	70→35/55←10 20/20 kPa	70→35/55←10 30/30 kPa	70→35/55←5 20/20 kPa	70→35/55←5 30/30 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M3-22H	M3-20H	M3-22H	M3-34H	M3-34H	M3-30H	M3-30H
100	M3-38H	M3-36H	M3-40H	M3-62H	M3-62H	M3-54H	M3-54H
150	M3-56H	M3-56H	M3-58H	M3-90H	M3-90H	M3-78H	M3-74H
200	M6M-22M	M6M-18M	M3-76H	M6M-18H	M6M-18H	M6M-18H	M6M-18H
300	M6M-30M	M6M-26M	M6-22M	M6M-26H	M6M-26H	M6M-26H	M6M-22H
400	M6M-40M	M6M-36M	M6-28M	M6M-34H	M6M-32H	M6M-34H	M6M-28H
500	M6M-48M	M6M-46M	M6-36M	M6M-42H	M6M-40H	M6M-42H	M6M-36H
750	M10M-44H	M10M-44H	M6-54M	M6M-66H	M6M-56H	M6M-66H	M6M-52H
1,000	M10M-60H	M10M-60H	M6-76M	M6M-92H	M6M-74H	M6M-92H	M6M-72H

Prim.in→out/out←Sec.in Max pressure drop prim/sec	70→30/60←5 50/50 kPa	70→25/60←10 20/20 kPa	65→20/55←10 20/25 kPa	60→30/55←25 30/30 kPa	60→25/55←5 20/20 kPa	60→25/55←5 30/30 kPa	6→20/55←10 20/25 kPa
Capacity, kW	Model	Model	Model	Model	Model	Model	Model
50	M6-10H	M6-14H	M6-18H	M6-42H	M6-14H	M6-14H	M6-32H
100	M6-14H	M6-20H	M6-32H	M6-78H	M6-24H	M6-24H	M6-58H
150	M6-16H	M6-28H	M6-44H	M6-114H	M6-34H	M6-34H	M6-84H
200	M6-20H	M6-36H	M6-56H	M6-150H	M6-42H	M6-42H	M6-110H
300	M6-28H	M6-52H	M6-82H	M10B-268H	M6-60H	M6-60H	M6-164H
400	M6-36H	M6-66H	M6-108H	M10B-354H	M6-78H	M6-78H	M10B-256H
500	M6-44H	M6-82H	M6-132H	M10B-440H	M6-96H	M6-96H	M10B-320H
750	M6-64H	M6-120H	M6-196H	-	M10B-136H	M10B-136H	-
1,000	M6-82H	M10B-148H	M10B-274H	-	M10B-178H	M10B-178H	-

Alfa Laval in brief

Alfa Laval is a leading global provider of specialized products and engineered solutions.

Our equipment, systems and services are dedicated to helping customers to optimize the performance of their processes. Time and time again.

We help our customers to heat, cool, separate and transport products such as oil, water, chemicals, beverages, foodstuffs, starch and pharmaceuticals.

Our worldwide organization works closely with customers in almost 100 countries to help them stay ahead.

How to contact Alfa Laval

Up-to-date Alfa Laval contact details for all countries are always available on our website at www.alfalaval.com

Alfa Laval reserves the right to change specifications without prior notification.

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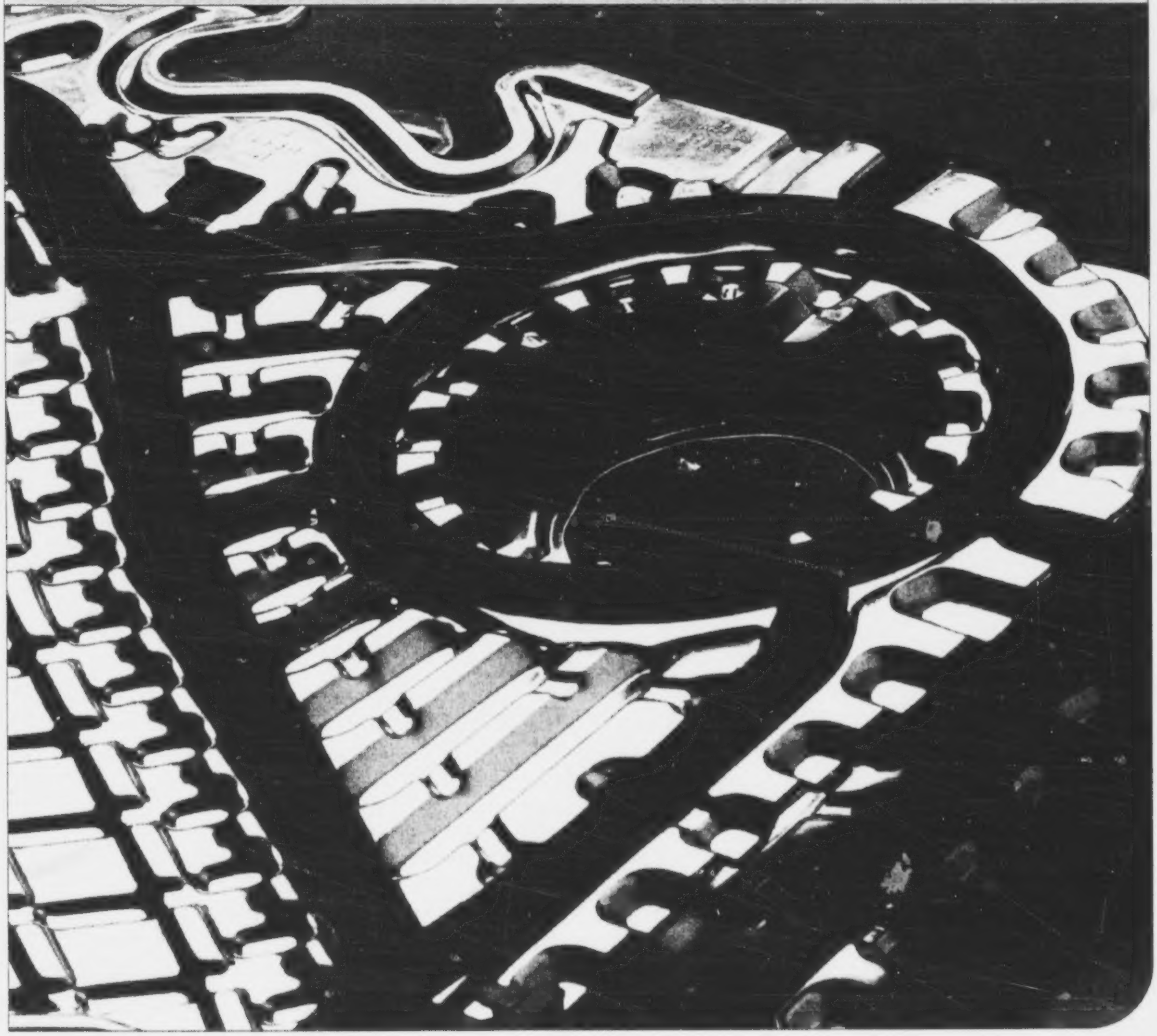
Plate Heat Exchanger

Operational and Maintenance Manual



How to contact Alfa Laval

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Canada: 1 888 ALFA CAN (253-2226)

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4405 Cox Road, Suite 130	Fax	+1 804 270 1370
Glen Allen, VA 23060 USA		
101 Milner Avenue	Phone	+1 416 299 6101
Scarborough, Ontario	Fax	+1 416 299 5476
M1S 4S6 Canada	Toll Free	+1 888 ALFA CAN (253-2226)
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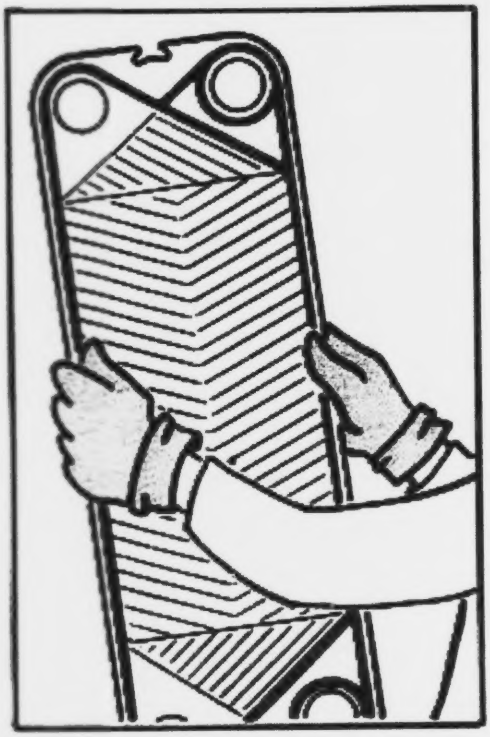
Col. La Loma	Fax	+52 55 3003 2727
54060 Tlalnepantla, Edo. de México		+52 55 3003 2728

Contact details for all countries are continually updated on our website.
Please visit www.alfalaval.com to access the information directly.

NOTICE



TO AVOID HAND INJURIES,
PROTECTIVE GLOVES
SHOULD ALWAYS BE WORN
WHEN HANDLING PLATES.

PROTECTIVE SHROUDS

IT IS THE RESPONSIBILITY OF EACH PERSON OPERATING OR REPAIRING EQUIPMENT TO TAKE THE NECESSARY PRECAUTIONS TO COMPLY WITH ALL APPLICABLE SAFETY REGULATIONS.

ALFA LAVAL PROVIDES PROTECTIVE SHROUDS FOR ALL OUR PLATE HEAT EXCHANGERS. THESE SHROUDS WILL PREVENT POSSIBLE INJURIES AND/OR DAMAGE AS A RESULT OF SUDDEN LEAKAGE FROM THE PLATE PACKAGE.

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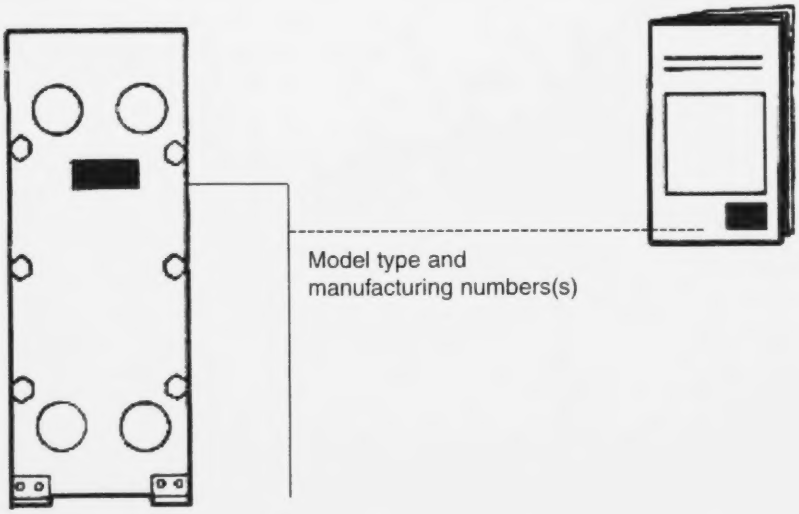
To our valued customer:

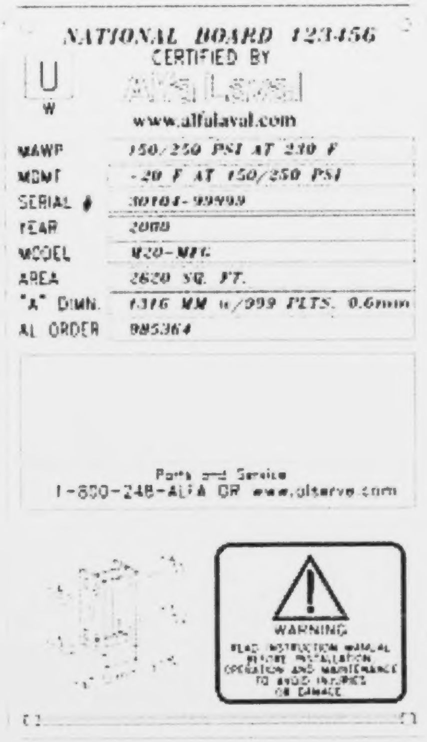
Thank you for purchasing an Alfa Laval Plate Heat Exchanger. As the world's largest manufacturer of Heat Exchangers, we are very proud of our products and services. We value you as our customer and wish to assure your satisfaction. We have prepared this Instruction Manual to assist you with your Alfa Laval Plate Heat Exchanger in various situations. We suggest that you look through it carefully, and, above all, make it readily available to any personnel who may need it for reference.

2

The name plate - and the identification of the equipment



A name plate like the one shown below is fixed to the apparatus as shown above and it gives the following information



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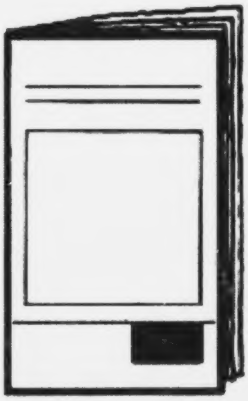
MAWP	150/250 PSI AT 230 F
MDMT	-20 F AT 150/250 PSI
SERIAL #	30101-99999
YEAR	2000
MODEL	M20-MFG
AREA	2620 SQ. FT.
"A" DIMN.	1316 MM w/999 PLTS. 0.6mm
AL ORDER	985364

Parts and Service
1-800-248-ALFA OR www.alserve.com

WARNING
READ INSTRUCTION MANUAL
BEFORE INSTALLATION
OPERATION AND MAINTENANCE
TO AVOID INJURIES
OR DAMAGE

The name plate
- and the identification of the equipment



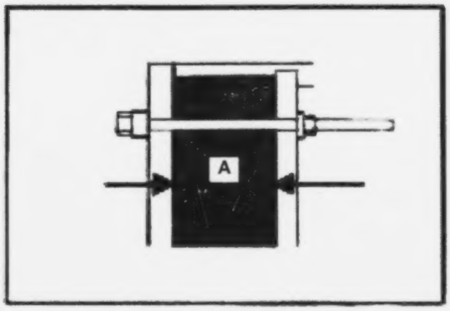
This instruction manual has been issued for many different models of Alfa Laval *industrial* PHEs. There are separate manuals for *industrial, sanitary, spiral, alfa rex, brazed & evaporator/condensor* heat exchangers.

- WHENEVER USING THE MANUAL, CHECK FIRST THAT THE SERIAL NUMBER ON THE FRONT COVER IS IDENTICAL TO THAT ON THE NAME PLATE OF THE EQUIPMENT.
- IN ALL CORRESPONDENCE WITH ALFA LAVAL, PLEASE REFER TO THE MANUFACTURING SERIAL NUMBER, FOR TRUE IDENTIFICATION OF THE EQUIPMENT.
- WHENEVER CONTACTING ALFA LAVAL ABOUT A PART FOR YOUR PLATE HEAT EXCHANGER, BE SURE TO STATE THE MANUFACTURING SERIAL NO.(S), AND MODEL TYPE.

3 General

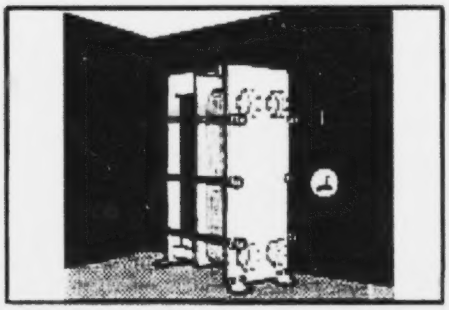
STORAGE

In this section, names of heat exchanger parts are mentioned for the first time. For your information, see Chapters 4A or 4B FUNCTION.



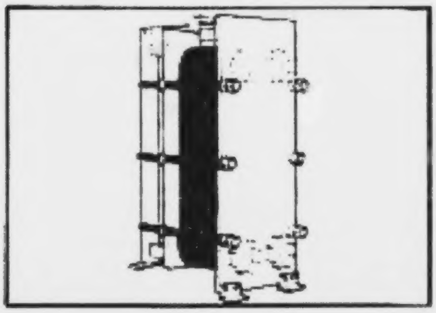
1. Unless otherwise agreed, ALFA LAVAL delivers the plate heat exchanger ready to be put in service upon arrival. This means that the plate package is tightened to its correct measurement A.

Should it be necessary, however, to store the equipment for a longer period (1 month or more) before, certain precautions should be made in order to prevent unnecessary wear of the equipment:



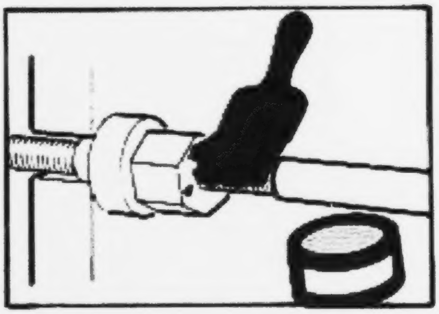
2. Preferably, the heat exchanger should be stored inside, in a room with a temperature around 15 to 20 degrees Celsius (60 to 70 degrees Fahrenheit) and humidity around 70%

> There should ABSOLUTELY NOT be any OZONE-PRODUCING equipment in the room, like electric motors or arc-welding equipment, since ozone destroys many rubber materials (cracking).
>
> Do not store organic solvents or acids in the room.
>
> Avoid heat or ultraviolet radiation.



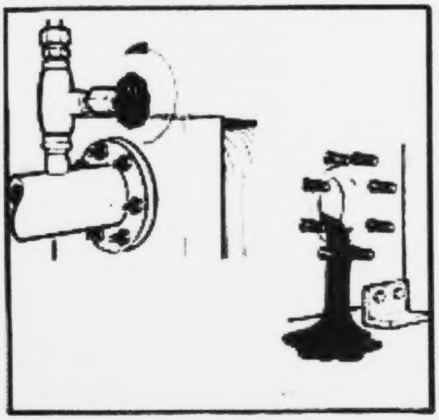
3. Wrapping the PHE with a non-transparent plastic film is a good precaution. Use of transparent film can alter paint color if unit is stored in direct sunlight.

STORAGE



4. The tightening bolts should be well covered with good rust preventing coating, suitable types (LUBRIPLATE FGL-2 or Equivalent) and if not connected to the pipe system, the connections should be covered.

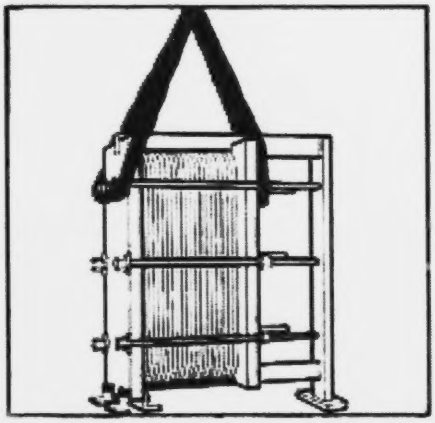
   If the heat exchanger must be stored outdoors, the precautions mentioned above should be taken as far as practical. The need for protection against the climate etc. is of course even more important in this case.



5. If for any reason the heat exchanger is removed from service for a long period, it is advantageous to follow the advice above, even if the equipment is not moved from the location.

   The heat exchanger should be VENTED AND DRAINED, and depending on the media processed, it is recommended to RINSE AND DRY it, before it is stored.

LIFTING



1. Whenever the heat exchanger is lifted, straps should be placed around tightening bolts on both sides of the unit, as shown in picture. If lifting lugs or lifting eyes are provided, always use chains or lifting cables rated above the published weight of the heat exchanger.

NEVER LIFT BY THE CONNECTIONS OR THE STUDS AROUND THEM!

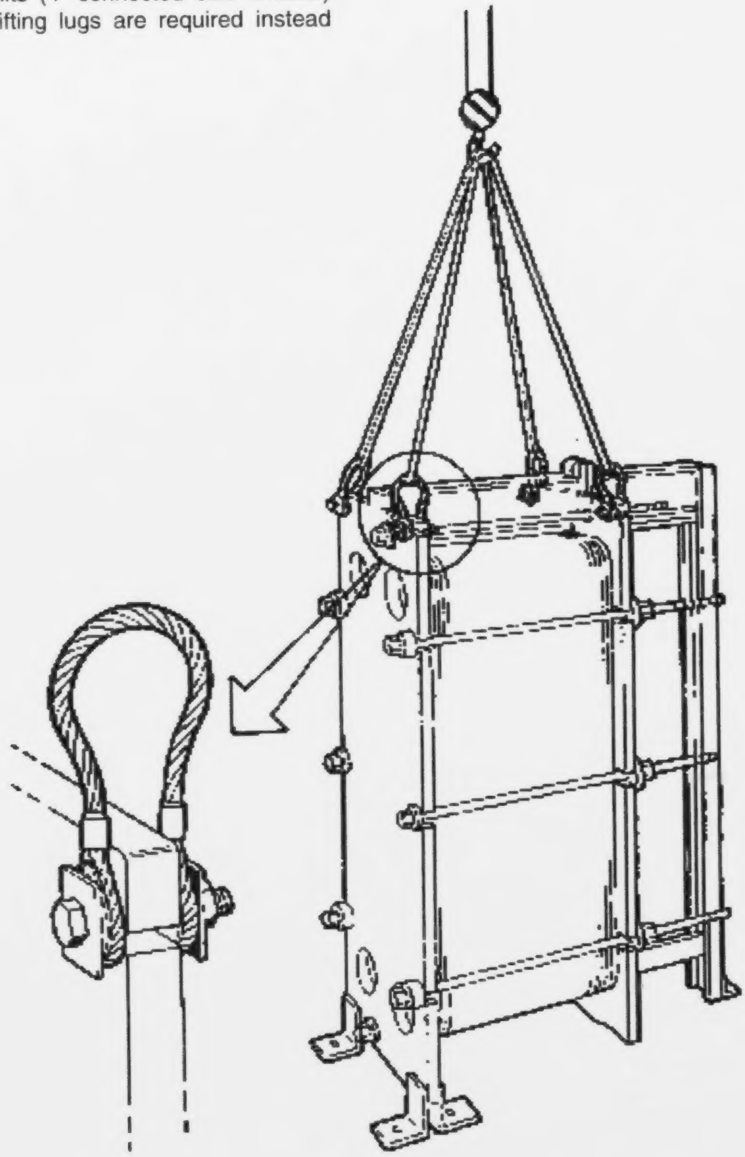
LIFTING CONTINUED

If Lifting Lugs are provided

If you are to lift the heat exchanger itself, straps should be used. They should be placed as shown on the picture.

On smaller units (4" connected size smaller) typically two lifting lugs are required instead of four.

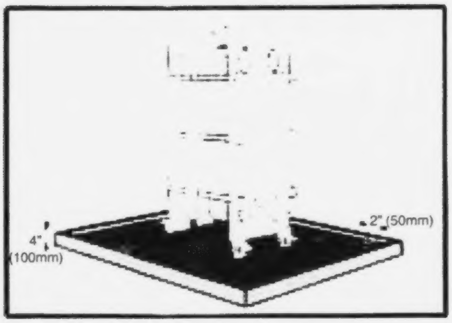
WARNING!
Never lift by the connections or the studs around them.



General

FOUNDATIONS.

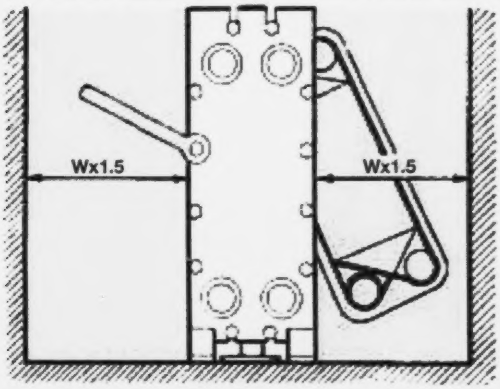
All information necessary for the preparation of the foundation appears on the data sheet provided by ALFA LAVAL.



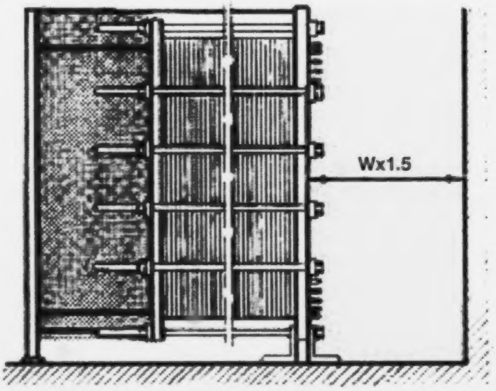
In some cases (installation on board a ship, when processing corrosive liquids, etc.) it may be practical to place the heat exchanger in a DRAINAGE BOX (with capacity for the total volume of the heat exchanger). The outlet of the drainage box should be generously dimensioned, not less than (2") 50 mm diameter.

INSTALLATION.

BEFORE connecting any piping to the heat exchanger, MAKE SURE THAT ALL FOREIGN OBJECTS HAVE BEEN FLUSHED OUT OF THE SYSTEM!



PLEASE OBSERVE THAT
The measurements given in the picture above are recommended by ALFA LAVAL, it is necessary to leave free space around the equipment, to provide access and make future service possible. Except for a place to put the plates, if removed from the heat exchanger, NO FURTHER SPACE is required for servicing the PHE.



PLEASE OBSERVE THAT
The measurements given in the picture are recommended by ALFA LAVAL, to provide reasonably good working conditions during installation of the heat exchanger as well as for future maintenance and service. If floor space is restricted, the dimensions suggested can be reduced. It is left to the purchaser to decide just how much access space is required.

▨ This field should be kept free from fixed installations.

▨ Recommended free space for opening and closing.

PIPES

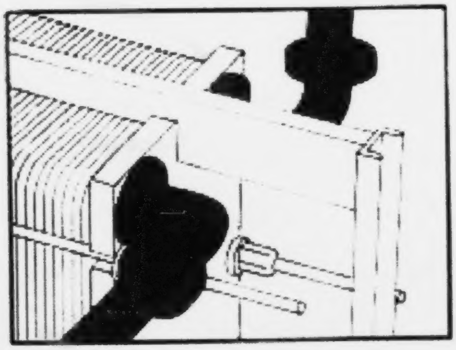
Always ensure that no measurable stress is placed on the heat exchanger by the piping system.

SHUT OFF VALVES

To enable the heat exchanger to be opened when necessary shut off valves should be provided on all connections.

PRESSURE RELIEF DEVICES

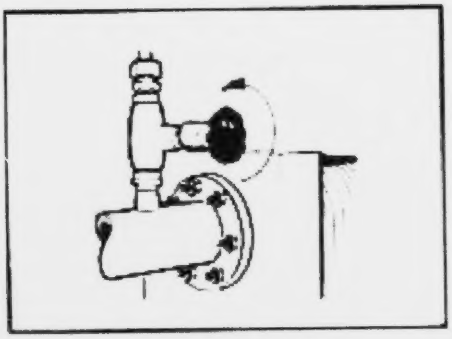
It is the responsibility of the user to ensure that the required pressure relief devices are properly installed prior to initial operation. Refer to the applicable Code(s) and corresponding Standard(s) for proper size requirements of these pressure relief devices.



CONNECTIONS ON THE PRESSURE PLATE (REAR COVER)

Some plate heat exchangers may also have connections on the pressure plate. In such cases, it is important to check against the drawing or the name plate that the plate pack has been tightened to the right measurement before the piping is connected.

Whenever piping is connected to the pressure plate, a short 90° spool piece shall be installed between the heat exchanger and the piping. These should be directed upwards or sideways. This simplifies pressure plate removal during servicing.



Venting of both sides of the heat exchanger must be provided. This is important and enables air to be drawn from the system during start-up. It also enables air or gas to be removed during operation, and it enables faster drainage.

Special Loose Flange Connections

Loose Flanges are provided on certain model types due to interference. When provided these flanges shall be incorporated into the piping.

MODELS WITH BOTH "S" AND "T" PORT CONNECTIONS

M6-FD, M6-MFD, M6-MWFD, M10-BFD, M10-MFD, M10-BWFD, M10-BDFD, M20-MFD*, M20-MWFD*

MODEL TYPES WITH LOOSE FLANGE ON T PORT CONNECTIONS ONLY:

M6-FG, M6-MFG, M6-MWFG, M10-BFG, M10-MFG, M10-BWFG, M10-BDFG, V28-FD*, V45-FD*, M20-MFG, M20-MWFG

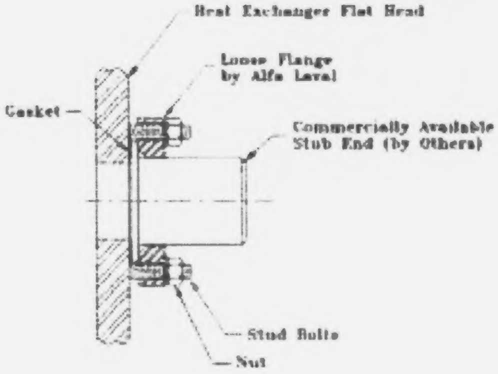
* Loose flange only when design pressures above 230 psi.

Notes:
1) Sports connections on these model types utilized industry standard flanges.
2) Not all exchangers require T port connections.

PIPING CONNECTION

The loose flange is connected to piping by use of a commercially available stub end of same material as the piping.

The stub end is installed as shown and then butt weld to the piping.


Heat Exchanger Flat Head
Loose Flange by Alfa Laval
Gasket
Commercially Available Stub End (by Others)
Stud Bolts
Nut

4A LIST OF PARALLEL FLOW UNITS

“A” SERIES UNITS:

AM10-FG; AM10-FS

A15-BFL; A15-BFG; A15-BFD; A15-BWFG; A15-BWFD

A20-BFL; A20-BFG; A20-BFD

AM20-FG; AM20-BFG; AM20-WFG; AM20-SFG; AM20-DWFG

AK20-FG; AK20-FD; T200-FG; T200-FD

AX30-BFG; AX30-BFD; AX30-BWFG; AX30-BWFD

A35-HA

“M” SERIES UNITS:

M3-VG

M6-FG; M6-FD; M6-MFG; M6-MFD; M6-MWFD/FG/FDR/FGR

M10-BFM; M10-BFG; M10-BFD; M10-MFG; M10-MFD;

M10-BWFG; M10-BWFD; M10-BWFGR, M10-BWFDR

M15-BFG; M15-BFD; M15-BFS; M15-MFG;

M15-MFD; M15-MFS; MK15-BWFD; MK15-BWFG

M20-MFG; M20-MFM; M20-MFD; M20-MWFG; M20-MWFD

M30-FM; M30-FG; M30-FD

MA30-FD; MA30-FG; MA30-WFG; MA30-WFD

MX25-BFG; MX25-BFD; MX25-BFS

EC500-WTFE; EC500-WTFL

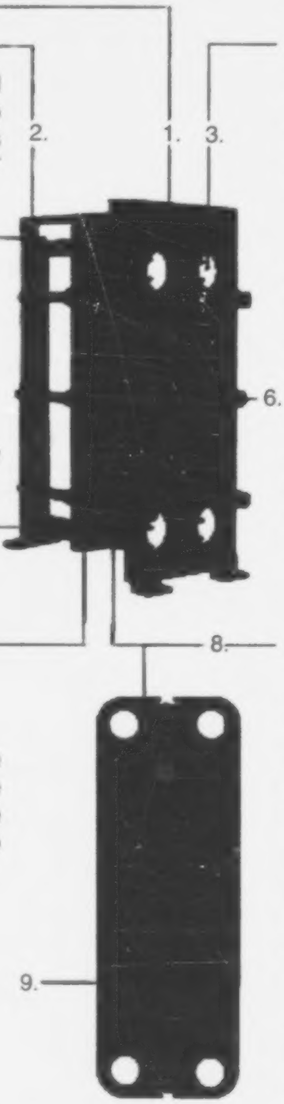
“V” SERIES UNITS:

V8-VG, V13-FG, V13-FD, V20-FG, V20-FD

Function

THE MAIN COMPONENTS OF THE PLATE HEAT EXCHANGER AND THEIR FUNCTIONS.

In ALFA LAVAL Plate Heat Exchangers, heat is transferred from one medium to another through thin metal plates which have been pressed into a special pattern.



1. FRAME PLATE

2. SUPPORT COLUMN
The two bars are suspended between the FRAME PLATE, to which in most cases the piping is connected, and a SUPPORT COLUMN.

4. CARRYING BAR

5. GUIDING BAR
The plates hang from a CARRYING BAR at the top and are kept in line by a GUIDING BAR at the bottom.

7. PRESSURE PLATE
The pressure plate is hung on the carrying bar and is moveable, as are the heat transfer plates. In some cases piping may be connected to the pressure plate.

3. CONNECTIONS
Holes matching the piping lead through the frame plate, permitting the media to enter into the heat exchanger. Threaded studs around the holes secure the pipes to the equipment. Depending on the application, metallic or rubber-type LININGS may protect the edges of the holes against corrosion.

6. TIGHTENING BOLTS
With the package of thin plates hanging between the frame plate and the pressure plate, a number of TIGHTENING BOLTS are used to press the thin plates together, bringing them into metallic contact, and to compress the gaskets, enough to seal off the narrow passages which have now been formed between the plates.

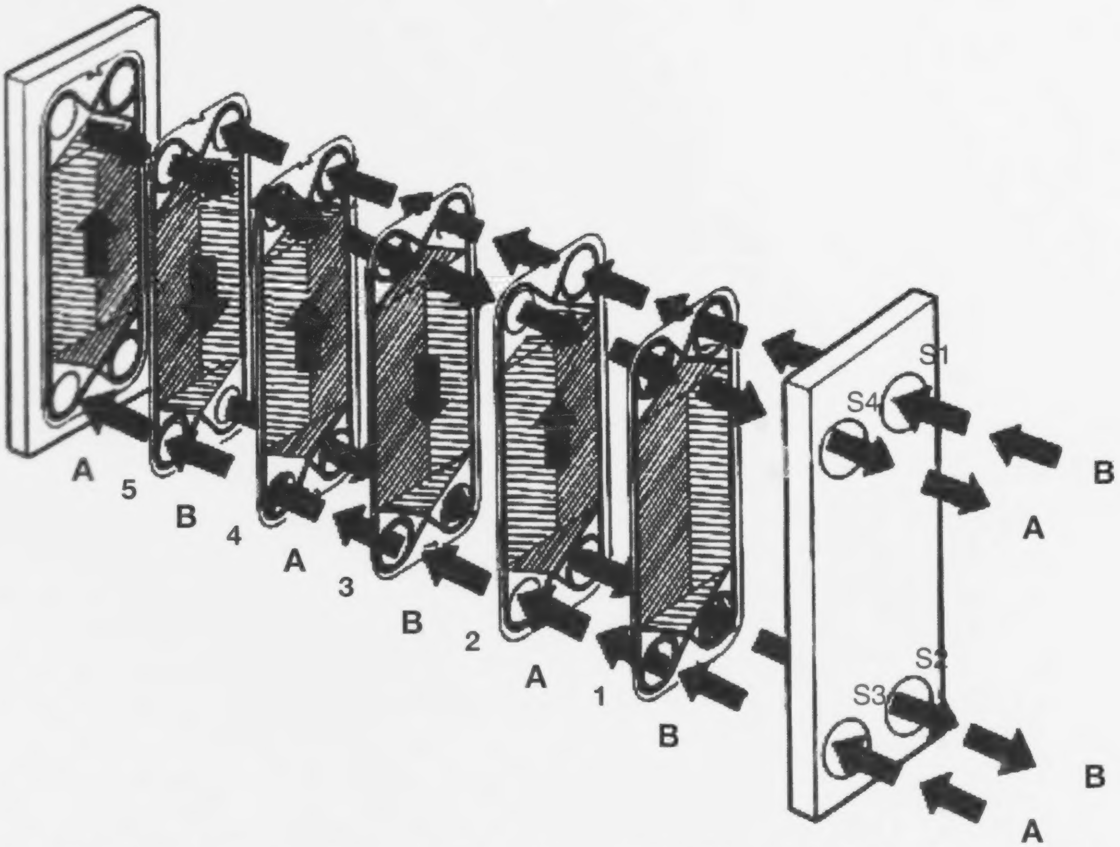
8. CHANNEL PLATES

9. GASKET
These plates are called CHANNEL PLATES. A groove along the rim of the plate and around the ports hold a GASKET, usually made of a rubber-type material.

Heat is transferred through the surface which is contained by the gasket, except for some small areas near the corners.

The number of plates in your heat exchanger is determined by the size of the heat transfer surface required.

How it works



When a package of plates are pressed together, the holes at the corners form continuous tunnels or manifolds, leading the media (which participate in the heat transfer process) from the inlets into the plate pack, where they are distributed in the narrow passages between the plates.

Because of the gasket arrangement on the plates, and the placing of "A" and "B" plates alternately, the two liquids enter alternate passages, e.g. the warm liquid between even number passages, and cold liquid between odd number passages.

Thus the media are separated by a thin metal wall. In most cases the liquids flow in opposite directions.

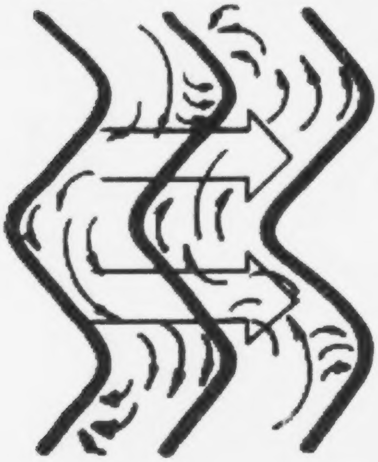
During the passage through the equipment, the warmer medium will give some of its heat energy to the thin wall, which instantly loses it again to the colder medium on the other side.

The warmer medium drops in temperature, while the colder one is heated up.

Finally, the media are led into similar hole-tunnels at the other end of the plates and discharged from the heat exchanger.

PARALLEL FLOW UNITS

Heat transfer



The purpose of the equipment is to transfer heat from one medium to another. Heat passes very easily through the thin wall separating the two media.

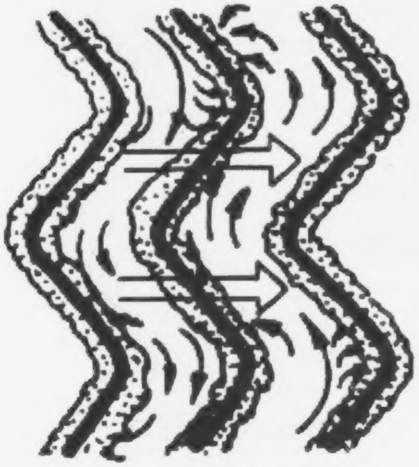
The novel pattern into which the plate material has been formed not only gives strength and rigidity, but greatly increases the rate of heat transfer from the warmer medium to the metal wall and from the wall to the other medium.

This high heat flow through the walls can be seriously reduced by the formation of deposits of various kinds on the wall surfaces.

The pattern of corrugation on Alfa Laval plates mentioned above induces highly turbulent flow. The turbulence gives strong resistance to the formation of deposits on the plate surface; however, it cannot always eliminate fouling.

The deposits may increase the total "wall thickness" substantially, and they consist of materials that have a much lower thermal conductivity than the metal plate. Consequently a layer of deposits can severely reduce the overall heat transfer rate.

The deposits will be considered in the chapter on MAINTENANCE and CLEANING. At this point we will only establish that this fouling is unwanted and can under certain circumstances, be harmful to the heat exchanger because corrosion may occur under the deposits.



Pressure drop

Pressure drops are wasted energy.

All pipe systems and equipment included in them offer resistance to media flowing through them.

Some pressure drop is unavoidable, but for a given PHE it should be kept as close as possible to the designed value.

The formation of deposits on the heat transfer surfaces instantly leads to a reduction of the free space between the plates. This means that more energy is needed to get the desired flow through the equipment.

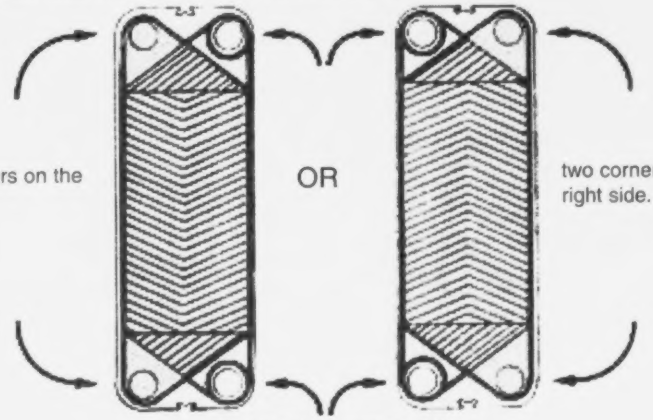
It is clear that the fouling of the surfaces is undesirable.

Larger particles and fibers may also be drawn into the heat exchanger and clog the passage ways if strainers or other means of protection have not been provided for.

A reduced ability by the heat exchanger to hold the desired temperatures, in combination with an increased pressure drop on any of the media, indicates that fouling or clogging is taking place.

For corrective action, see MAINTENANCE and CLEANING.

Studying the pictures, you will observe that on a plate hanging vertically, the gasket rests in a groove which includes the heat transfer area



and two corners on the left side.

OR

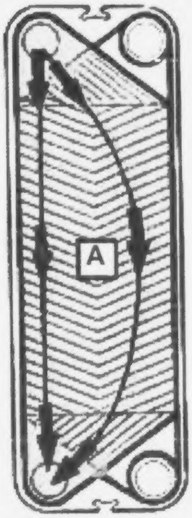
two corners on the right side.

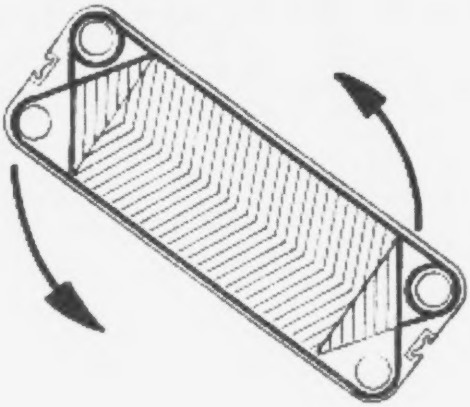
Smaller rings surround the two remaining corners.

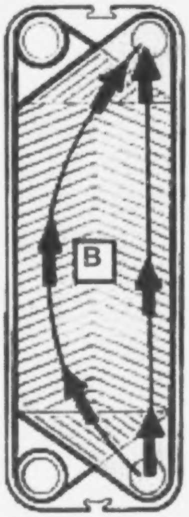
We decide that we will name the plates after these two situations.

An A-plate is a plate hanging with the chevron pointing downwards.

A B-plate is a plate hanging with the chevron pointing upwards.



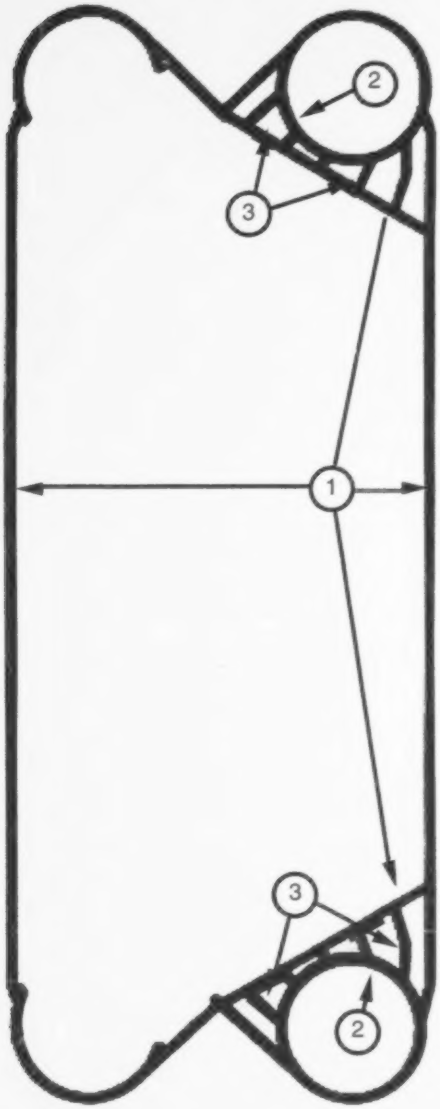




If we turn an A-plate upside down we will have a B-plate:

Gaskets

The GASKET is molded in one piece. The material is normally an elastomer, selected to suit the actual combination of temperature, chemical environment and possible other conditions that may be present.

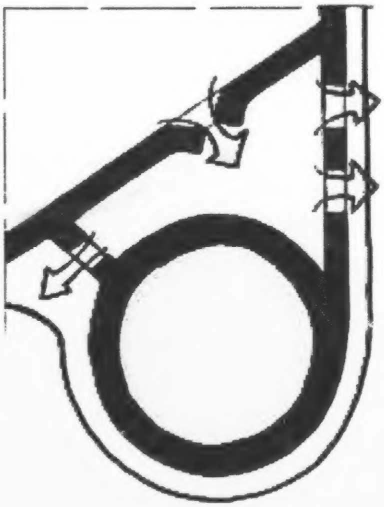


The one-piece gasket consists of:
1. One field gasket
2. Two ring gaskets
3. Links

The field gasket is by far the larger part containing the whole heat transfer area and the two corners connected to it. The ring gaskets seal off the remaining two corners.

These three pieces are held together by a few short links, which have no sealing function at all. Their purpose is simply to tie the pieces together and to add some support in certain areas. On some plate heat exchangers, the gasket is held in place on the plate by means of a suitable cement or glue.

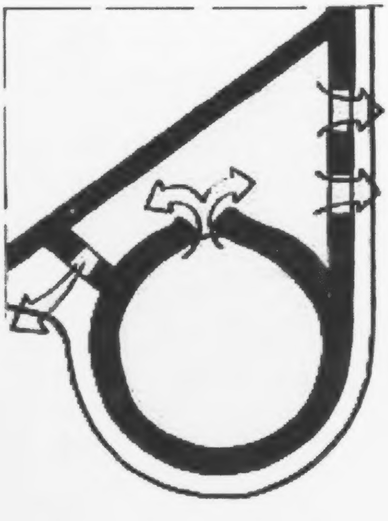
Gaskets



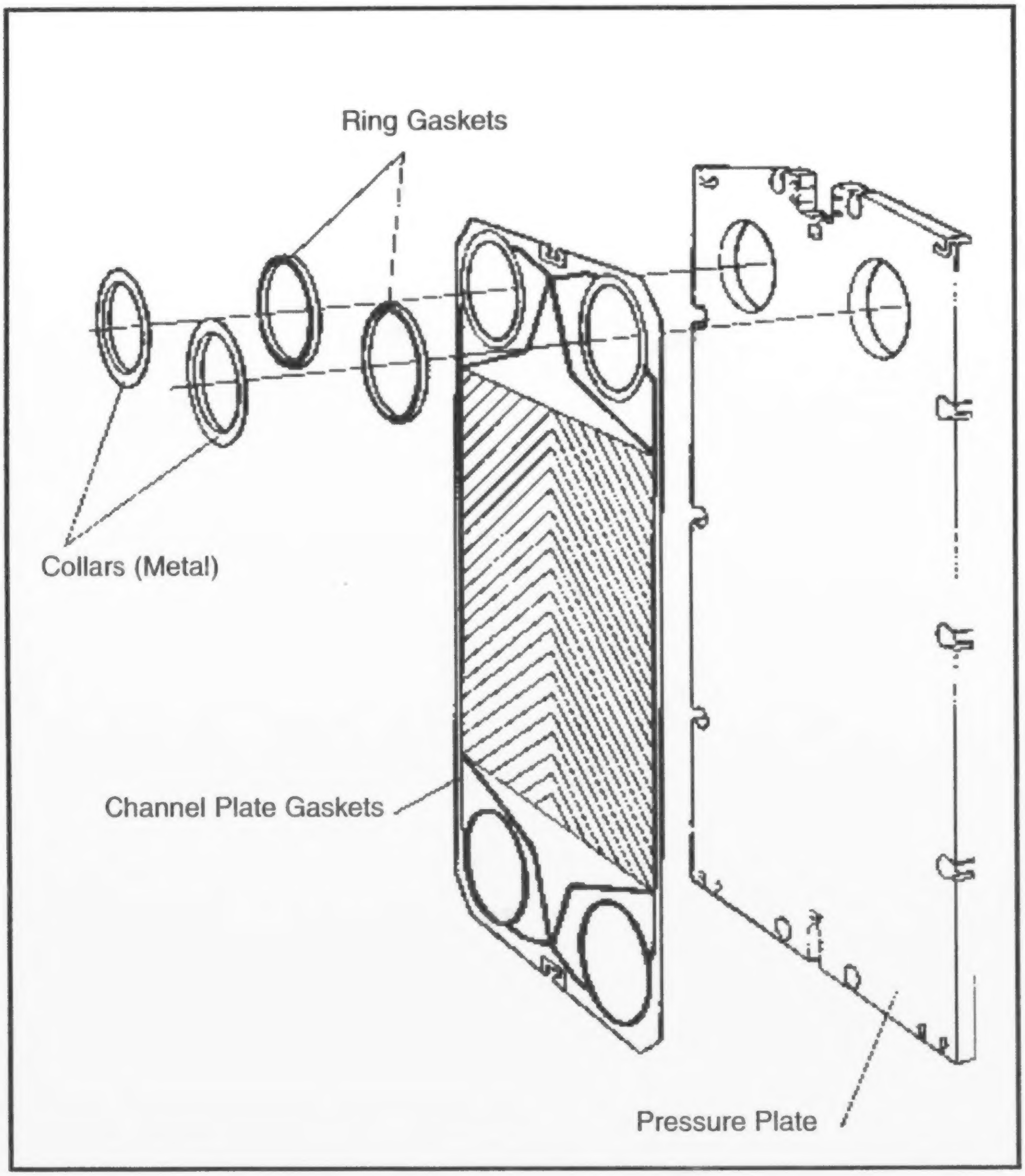
As already demonstrated, the two media are effectively kept apart by the ring and field gaskets. To prevent intermixing of the media in the corner areas where field and ring gaskets are very close to each other, the link pieces have a number of slots which opens the area between the field and ring gaskets to atmosphere. Any leakage of media across either gasket will escape from the heat exchanger through the slots.

It is important that these openings are kept clear. If they are not, there is a risk that should a leak occur in that region of the plate, there might be a local pressure build-up, which could allow one medium to mix with the other.

Care should be taken not to cut or scratch the gaskets while handling plates.



TRANSITION PLATE
M30, MX25, A20-B, AM20, AK20, T200, A15-B, M15, M10, M6


Ring Gaskets
Collars (Metal)
Channel Plate Gaskets
Pressure Plate

4B List of Diagonal Flow Units

"A" SERIES UNITS:

A10-BFG; A10-BFD
AX35-FG
A45-FG

"P" SERIES UNITS:

P2-FG; P2-VLCH; P2-DWFG
P3-E;P3-EH

"M" SERIES UNITS:

M3-XVG

"V" SERIES UNITS:

V28-FG, V28-FD, V45-FG, V45-FD, V110-FG, V110-FD, V170-FG, V170-FD, V280-FG, V280-FD

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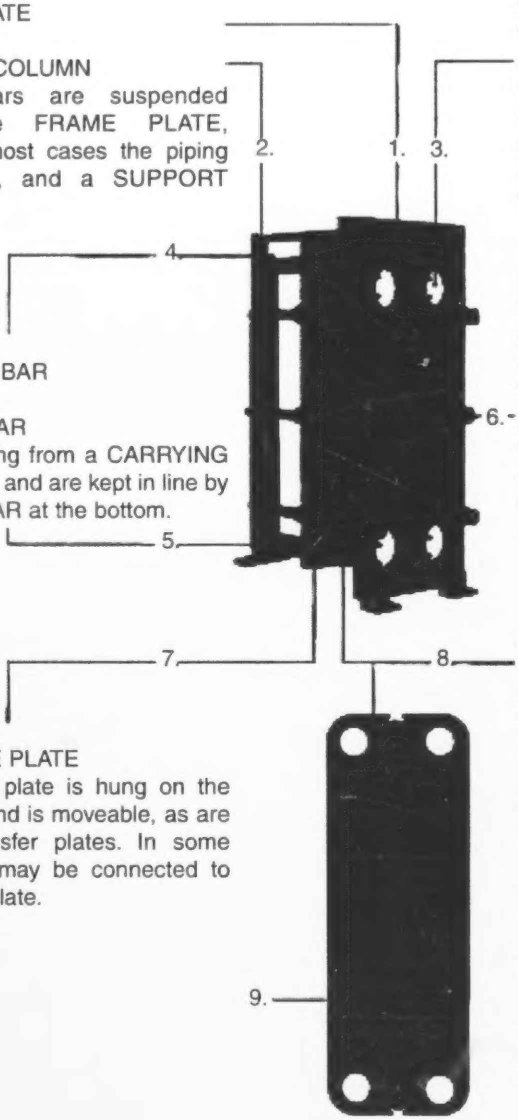

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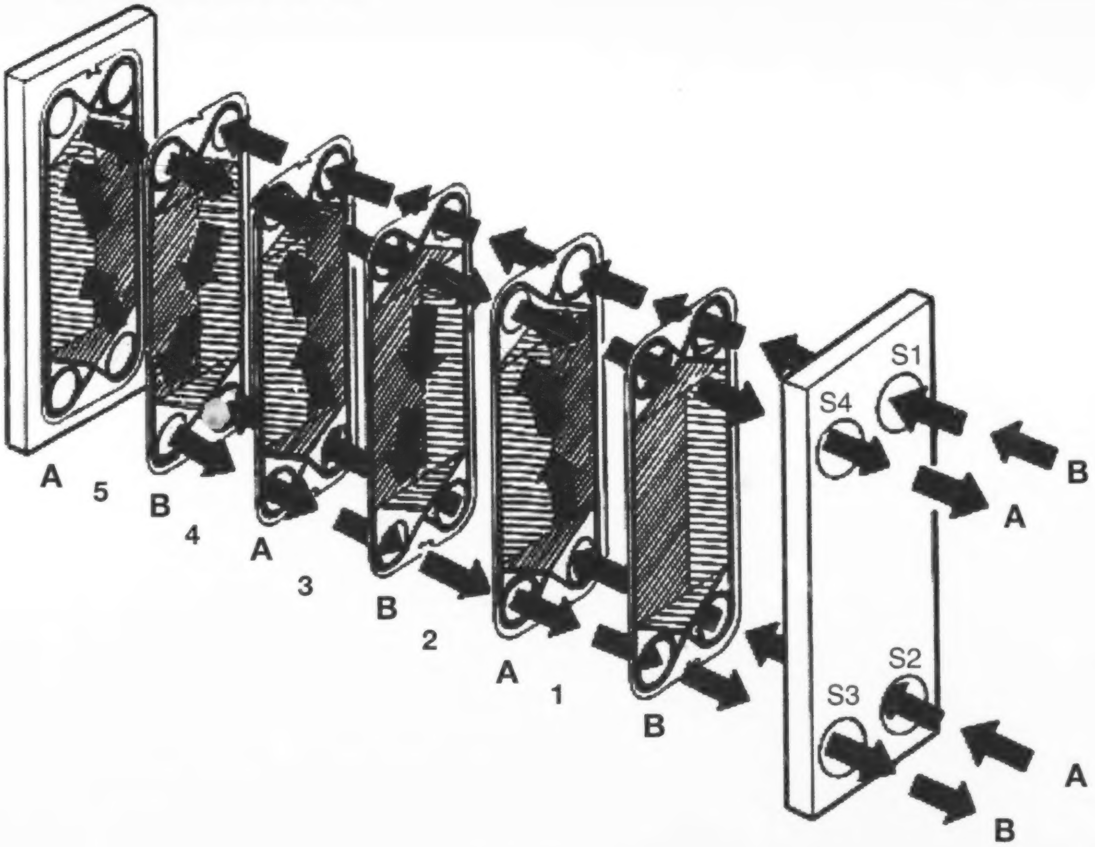

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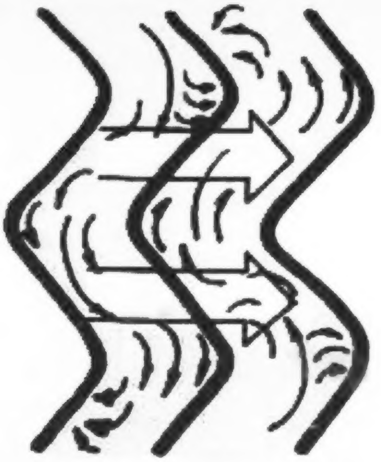
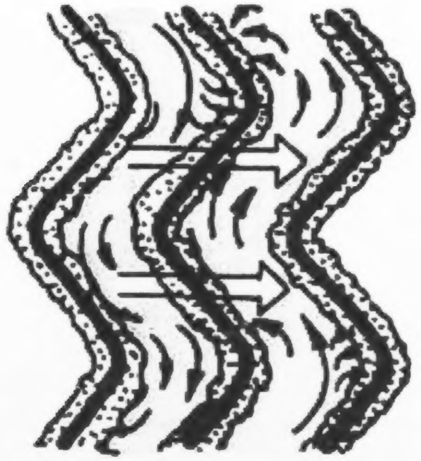
Heat transfer





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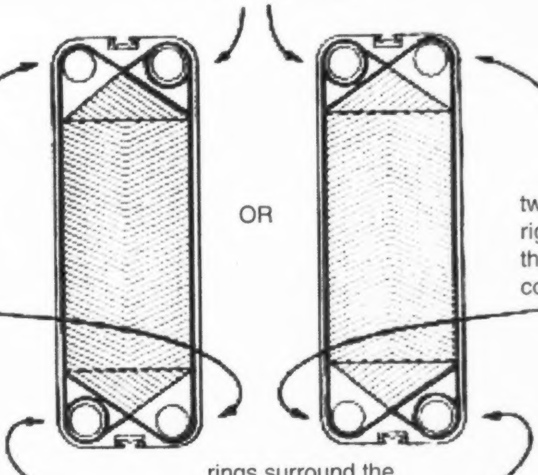
For corrective action, see MAINTENANCE and CLEANING.

Plates

Studying the pictures, you will observe that on a plate hanging vertically, the gasket rests in a groove which includes the heat transfer area



rings surround the remaining corners

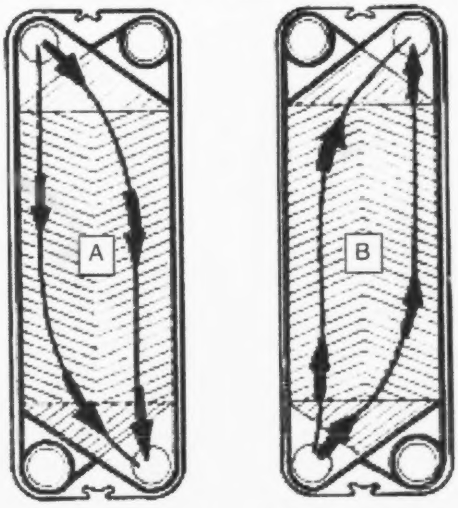
and two corners (the upper left-hand corner and the lower right-hand corner.

OR

two corners (the upper right-hand corner and the lower left-hand corner.

rings surround the two remaining corners

Depending on which two corners are included with the heat transfer area, the plate is called an A- or a B-Plate.

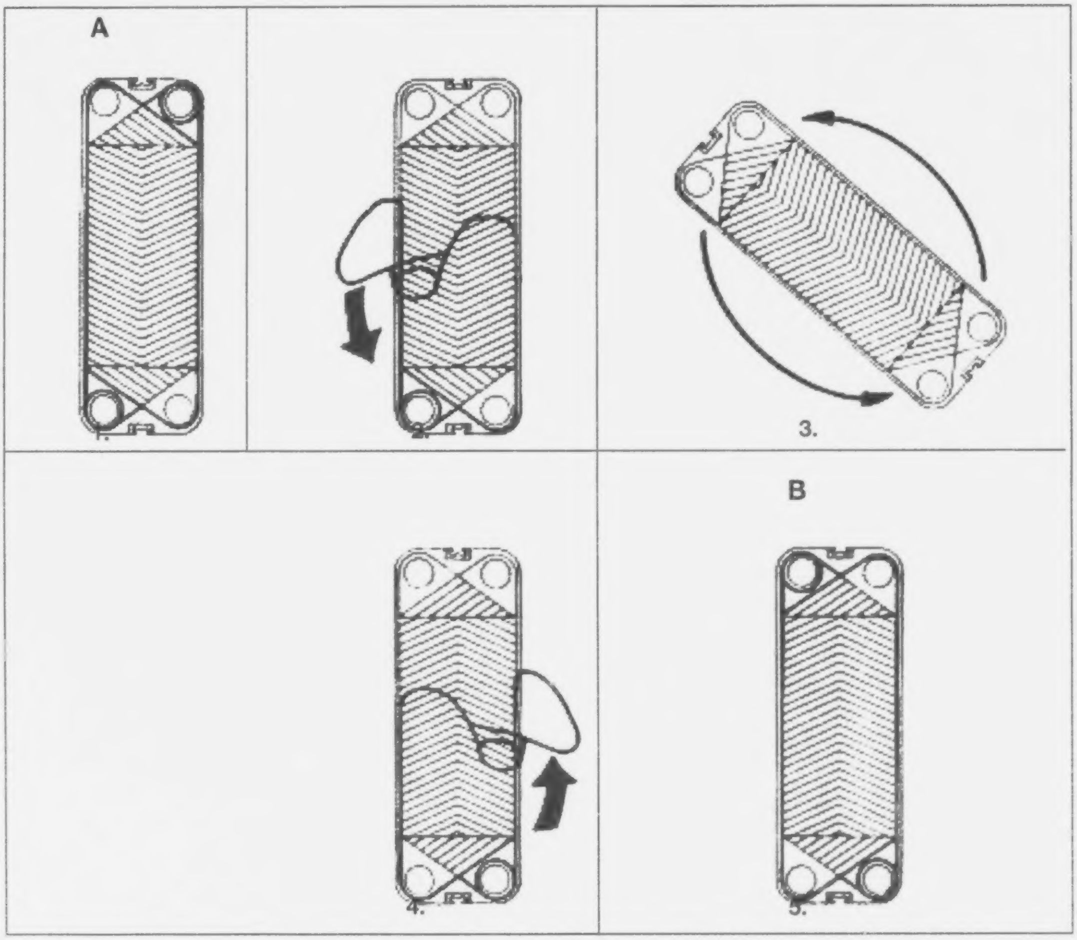


An A-plate is a plate hanging with the chevron pointing downwards.

A B-plate is a plate hanging with the chevron pointing upwards.

Plates

We can make a B-Plate from an A-plate or the opposite, by changing the gasket and turning the plate upside down.



Gaskets

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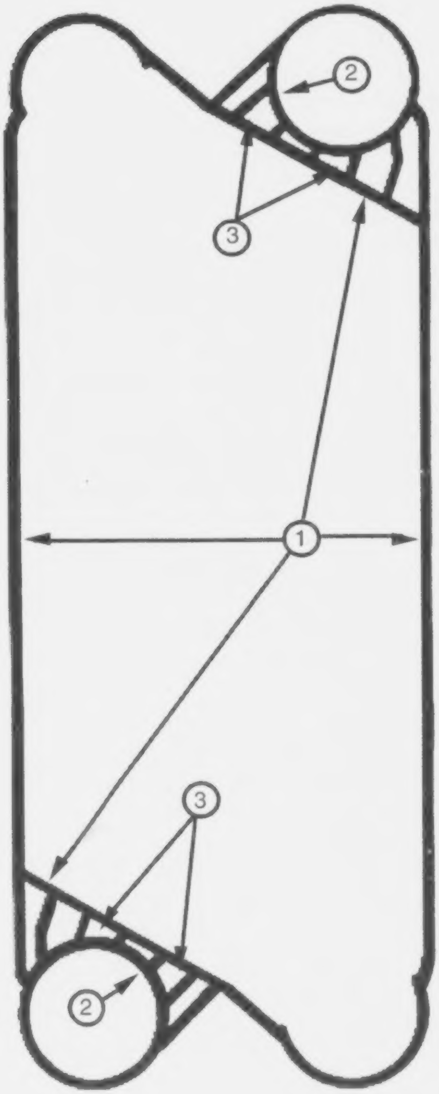

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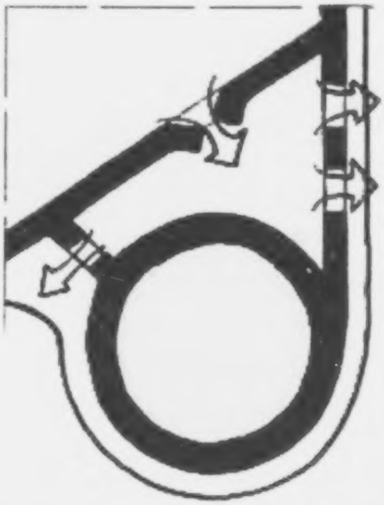
Gaskets



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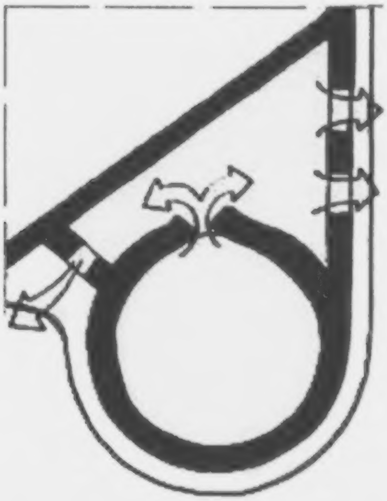
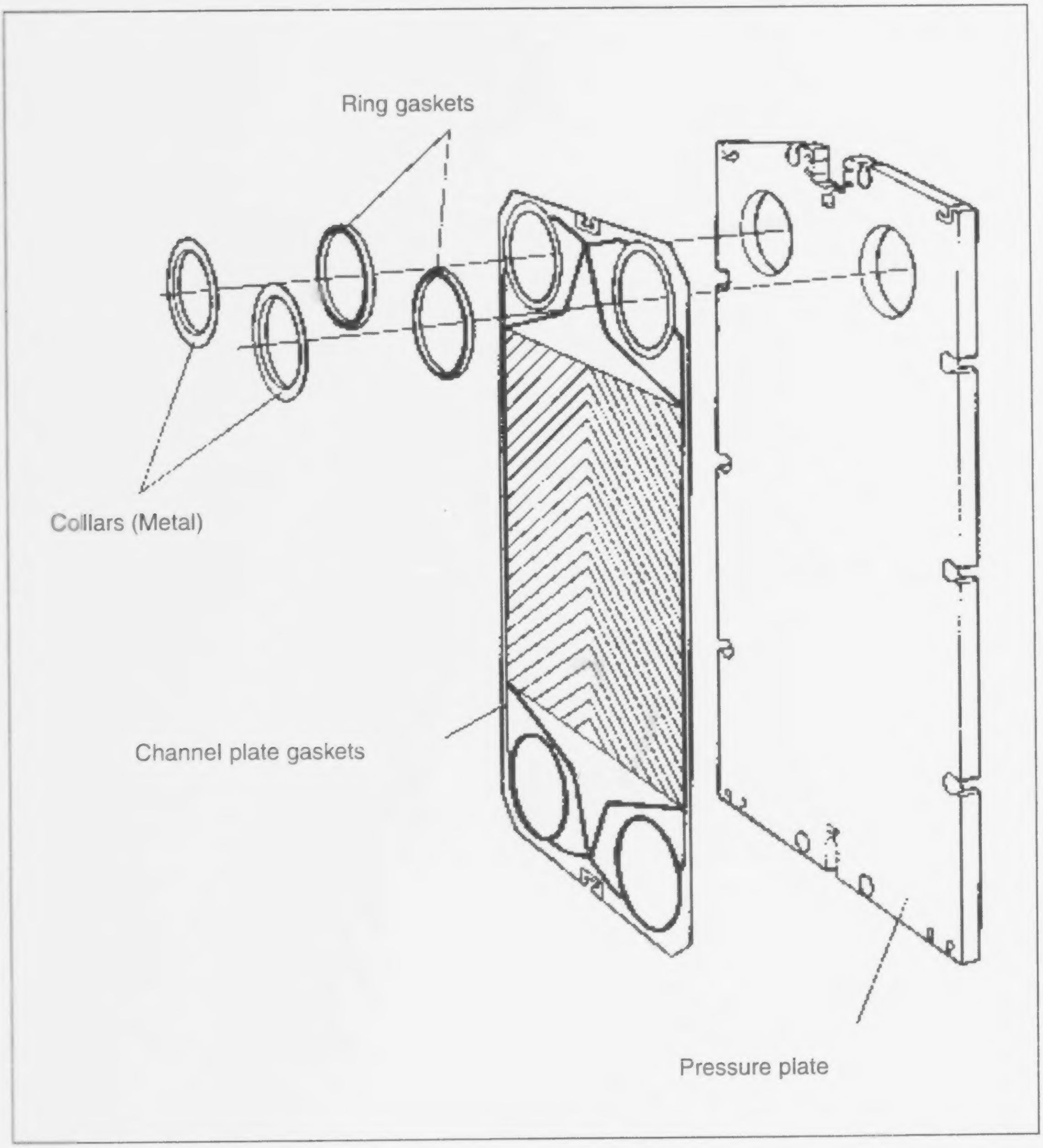
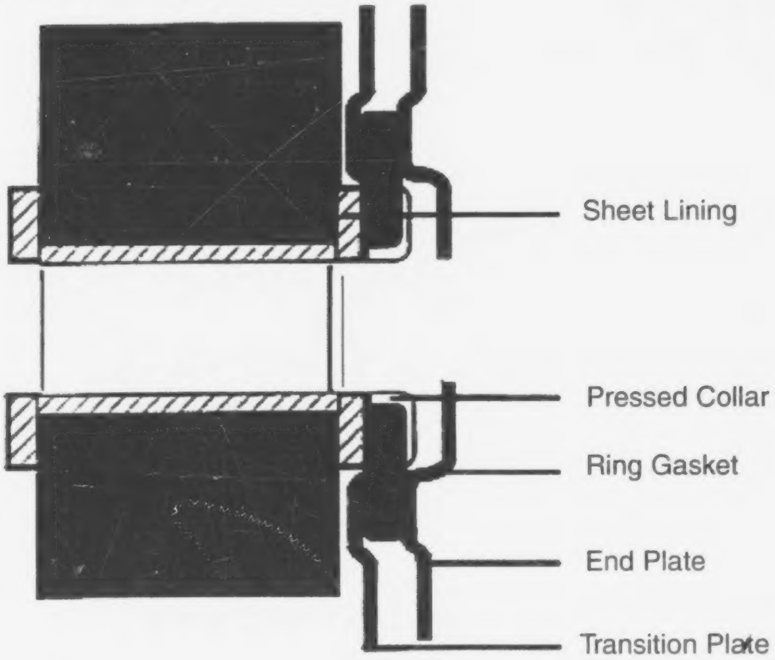


TRANSITION PLATE
M30, MX25, A20-B, AM20, AK20, T200, A15-B, M15, M10, M6

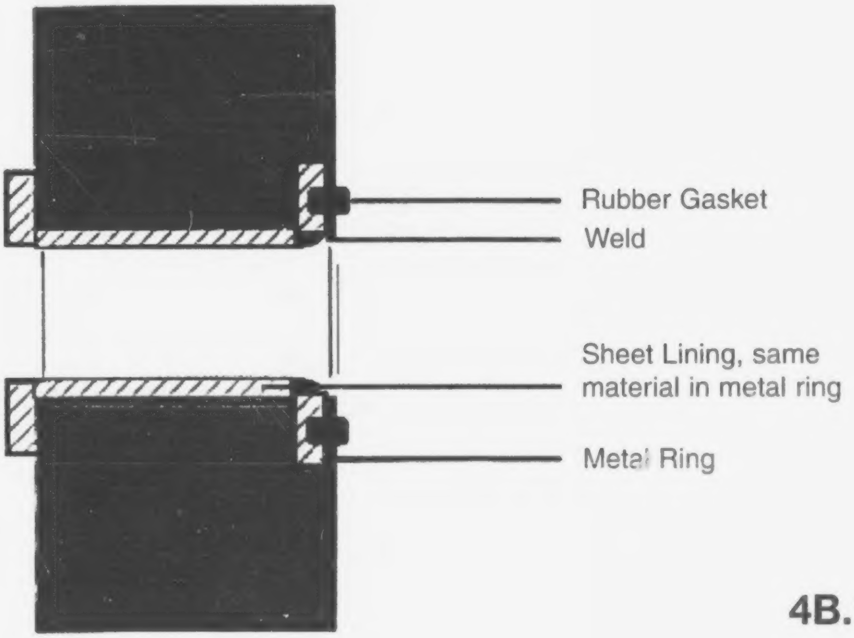

Ring gaskets
Collars (Metal)
Channel plate gaskets
Pressure plate

DIAGONAL FLOW UNITS

NON MACHINED PRESSURE PLATE

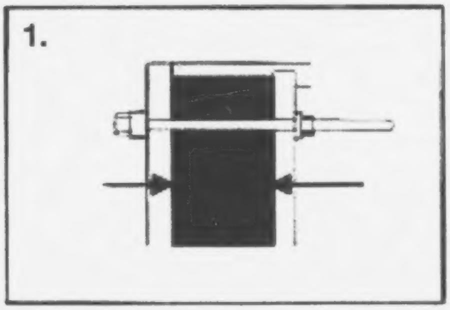

Sheet Lining
Pressed Collar
Ring Gasket
End Plate
Transition Plate

MACHINED PRESSURE PLATE (AX30, AM20 AND OBSOLETE FRAMES)

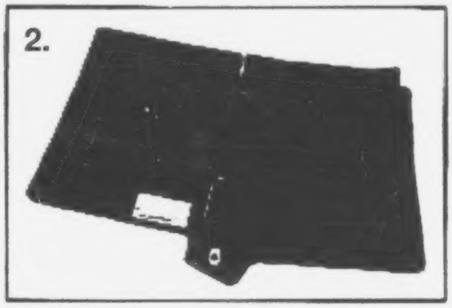

Rubber Gasket
Weld
Sheet Lining, same
material in metal ring
Metal Ring

5 Operation

START UP


1.

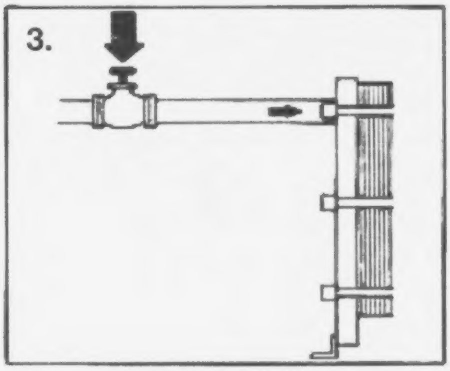
1. BEFORE STARTING UP FOR THE FIRST TIME OR AFTER A LONG TIME IN STORAGE: MAKE SURE THAT THE PLATE PACK IS COMPRESSED TO THE CORRECT MEASUREMENT A! Check with the Drawing or Nameplate, which is provided with each heat exchanger.


2.

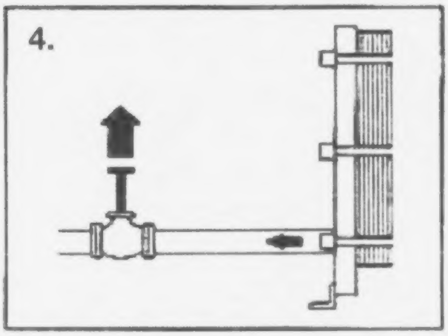
It is very important that the system to which the heat exchanger is connected, is protected against sudden and extreme variations of temperature and pressure. This is not only for the heat exchanger but also for the pipe system itself and every piece of equipment included in it.

This should be kept in mind whenever a maneuver is to be carried out, including starting up of the pumps in the system.

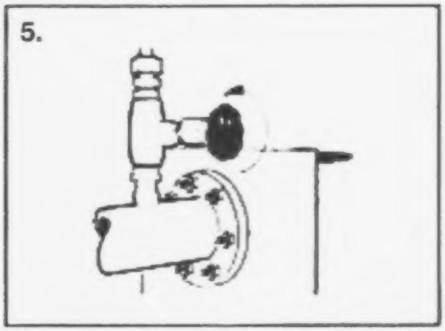
2. Before starting any pump, check whether instructions exist, telling you which pump should be started first.


3.

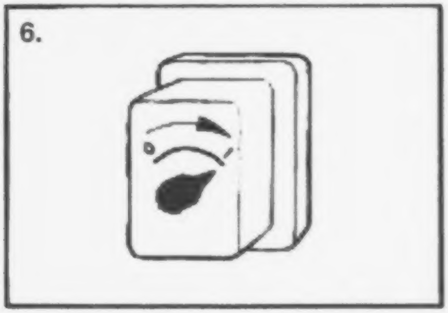
3. Check that the valve between the pump and the equipment, controlling the flow rate of the system which you are about to start up is closed.


4.

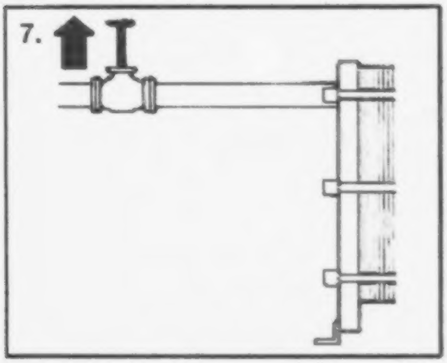
4. Check that the valve at the exit, if there is one, is fully open.



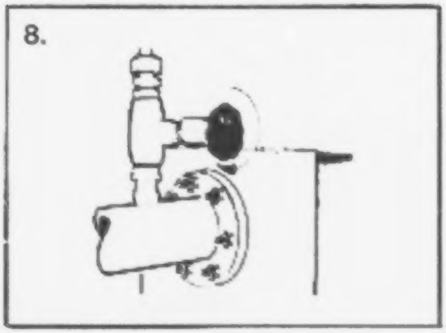
5. Open the vent.



6. Start the Pump.



7. Open the valve slowly.



8. When all air is out close the vent.

9. Repeat the procedure for the other media.

UNIT IN OPERATION

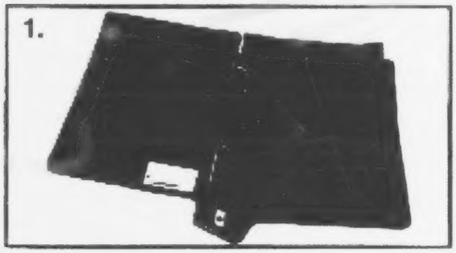
Any adjustment of the flowrates required to maintain correct temperatures or pressure drops should be made slowly, in order to prevent shocks to the system.

Problems in keeping up the performance of the heat exchanger may be caused by a change in some of the temperature conditions, the heat load or by fouling.

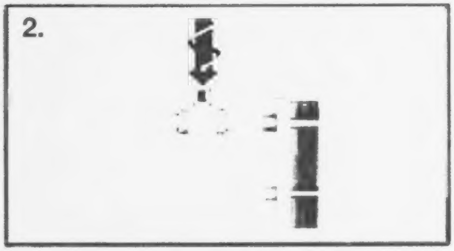
As long as the PHE is operating to satisfaction, it should be left without any interference.

SHUT-DOWN

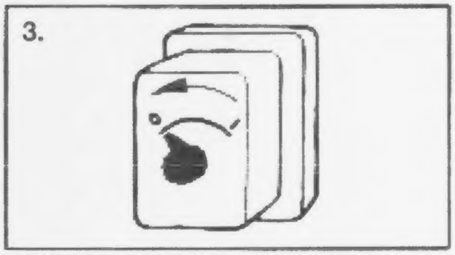
If the heat exchanger is going to be shut down - or if for any reason the pumps are to be stopped - the following procedure should be followed:



1. First establish whether instructions exist that specify which side should be stopped first.
2. SLOWLY CLOSE THE VALVE controlling the flow rate of the pump you are about to stop.



3. When the valve is closed, stop the pump.
4. Repeat the procedure for the other side.



5. Poor quality cooling water may be hazardous to metallic materials. Typical examples are corrosion of stainless steels and nickel alloys.

   If for any reason the heat exchanger is shut down for a longer period (more than a number of days), it should be drained, and depending on the media processed, it is recommendable to rinse and dry it.

THE RISKS OF NOT COMPLYING WITH THE START-UP AND SHUT-DOWN PROCEDURES.

A liquid in motion in a pipe system represents a lot of energy, and it must be very carefully dealt with.

Particularly when the fluid is stopped it is imperative that this is done smoothly.

NOTE!
For this reason fast-closing valves should not be used unless the pipes of the system are very short.

Valves must be operated gradually. The longer the pipes and the higher the flow rate, the more important this becomes.

WATER HAMMER is the name given to a short duration pressure peak, traveling along the pipe as a wave at the speed of sound, and resulting from a sudden deceleration of the motion of the fluid in a closed system.

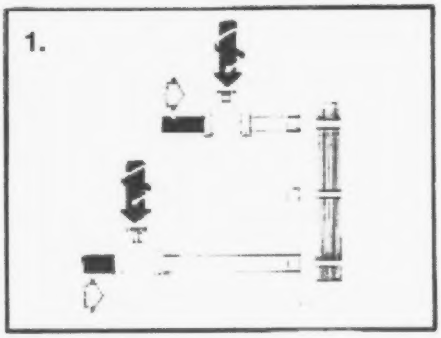
Thus, it is usually related to the shutting down of a system. However, when starting up a system with open valves and empty pipes, the fluid may burst into some obstacle, like a fine mesh strainer, a flow meter or a heat exchanger, causing a sudden reduction of the flow velocity - if not a complete halt, and so we may have the conditions of a Water Hammer.

In the worst case, the pressure surge caused by such a sudden stop of the motion of a fluid, can be several times the normal pressure of the system.

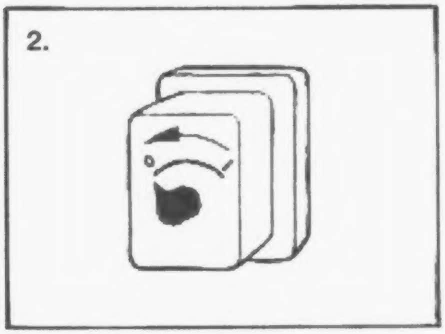
Therefore it is very important for the protection of the whole installation that start-ups and close-downs are carried out with great care.

6

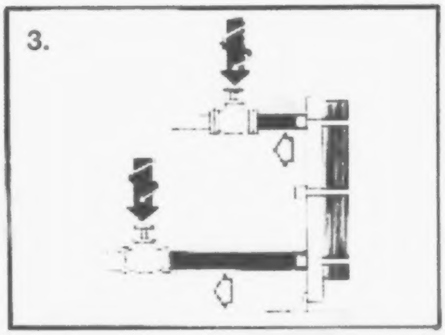
Opening



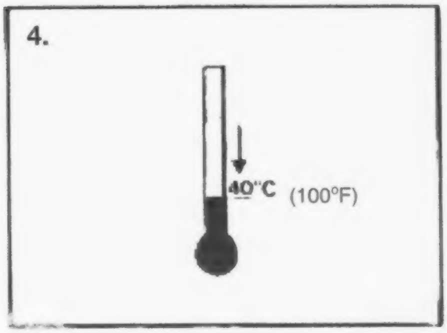
1. Slowly close the valves on the inlets. Shut off the inlet side, closing the highest pressure first.



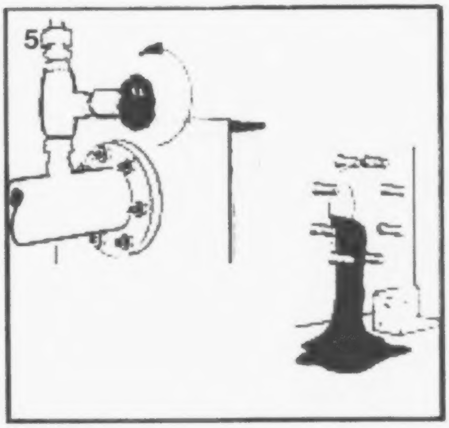
2. Switch off pumps.



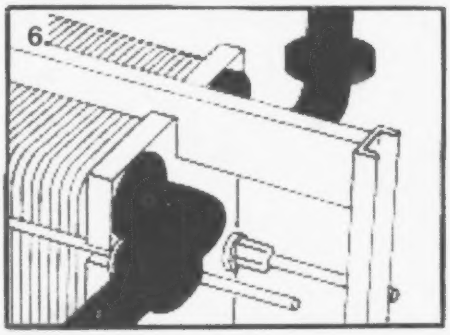
3. Close the valves on both outlets.



4. If the heat exchanger is hot, wait until it has cooled down to about 40°C (100°F).

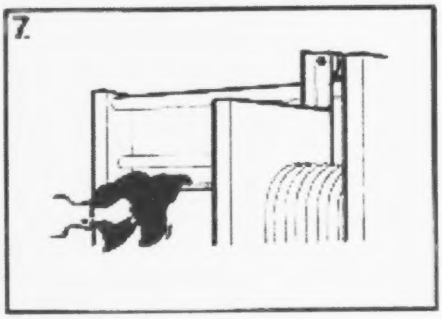


5. Drain

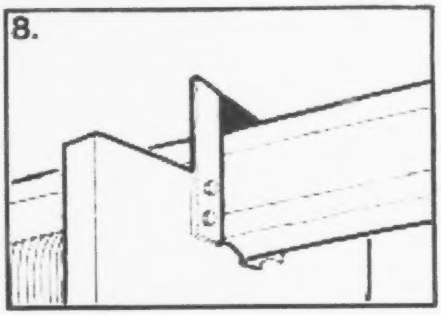


6. Dismantle any pipe bends connected to the pressure plate, so that it can be moved freely along the carrying bar.

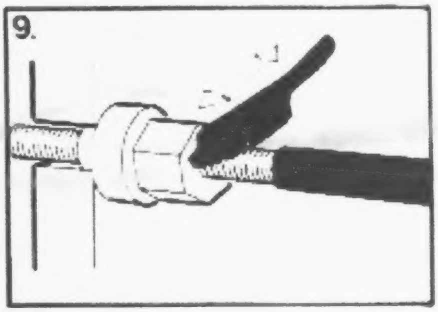
Opening



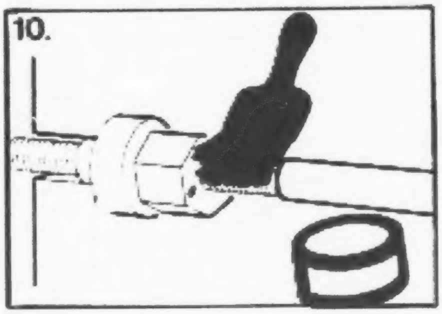
7. Inspect the sliding surfaces of the carrying bar and wipe clean



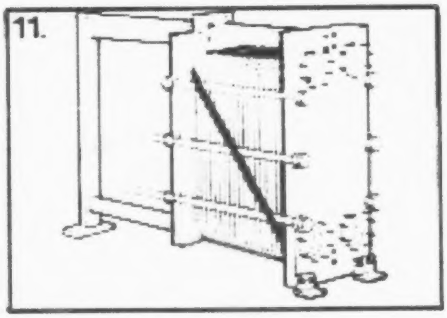
8. Inspect pressure plate roller.



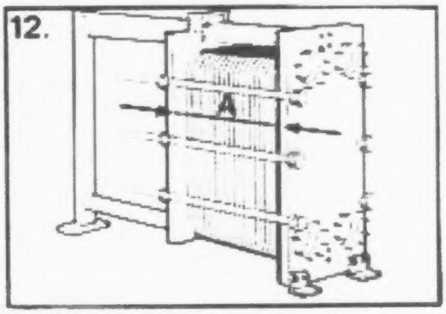
9. Pull back the plastic covers on the tightening bolts; brush the threads clean with a steel wire brush.



10. Lubricate the threads with a thin layer of grease, e.g LUBRIPLATE FGL-2 or equivalent.

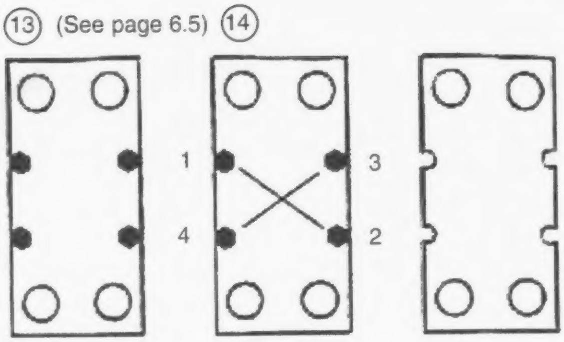


11. Mark the plate assembly on the outside by a diagonal line, or number the plates in sequence.



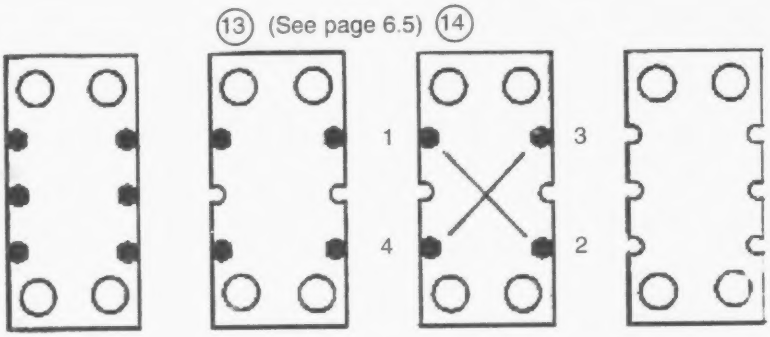
12. Measure and note the dimension A. Compare with code plate and PHE documentation for this same serial number.

	P2	A10B	TS6-M	AM10	M10B M10M
FG	X	X	X	X	
FM					X
FD			X		



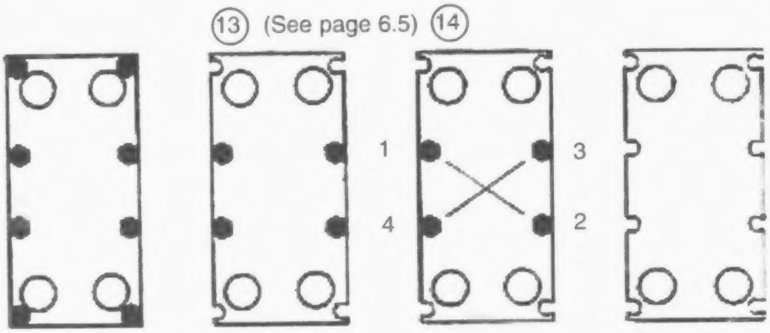
⑬ (See page 6.5) ⑭
1
3
4
2

	V8	P3	V13 V20	V28	M10B M10M	M10BW M10DW	M20-M
E		X					
FD			X				
FG			X	X	X	X	
FM							X
VG	X						



⑬ (See page 6.5) ⑭
1
3
4
2

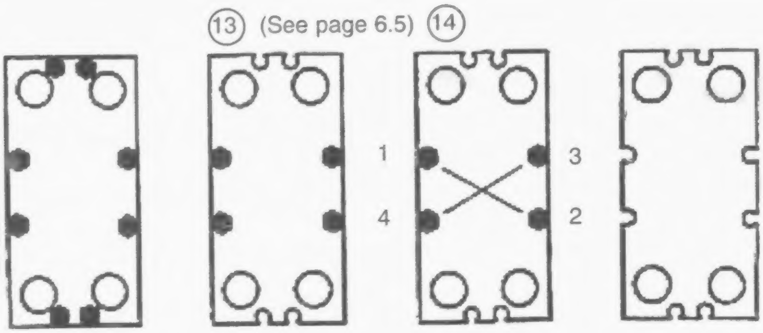
	M3	P2	P3	V28	V45
EH			X		
VG	X				
VLCH		X			
FG				X	X
FD				X	X



⑬ (See page 6.5) ⑭
1
3
4
2

	MX25B	A15BWA	15B	TS20-M	AM20 AM20B AM20W AM20S AM20DW	M6 M6M	M15M
FG		X	X	X	X	X	X
FD		X	X				X
FL			X				
FM	X			X			X
FS				X			

M6/M6-MFG & MX25-BFM ONLY HAS ONE BOLT TOP AND BOTTOM

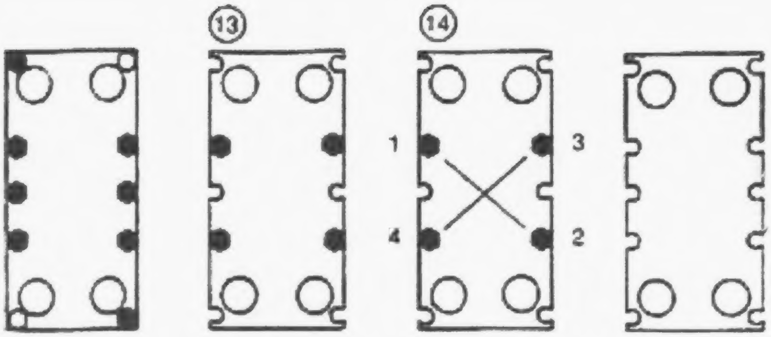


⑬ (See page 6.5) ⑭
1
3
4
2

Opening

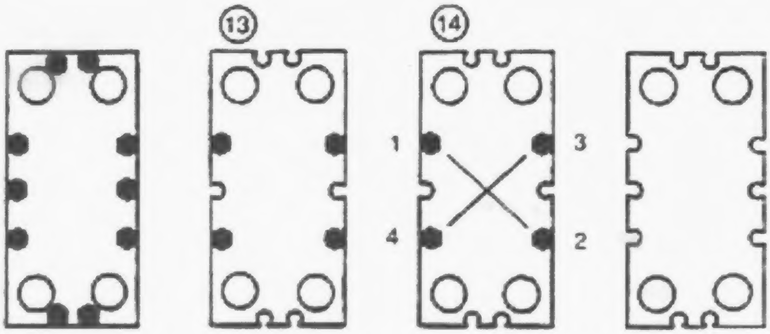
	M20-M			
FG				

M20-MFG ONLY HAS ONE BOLT TOP AND BOTTOM

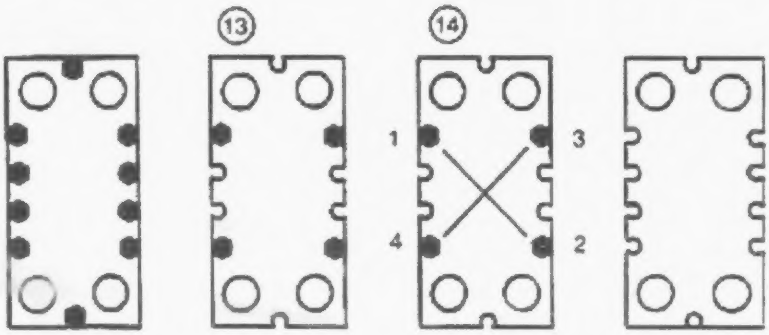


	M15B M15F	A20B	T200	M6 AK20 M6DW	M6M M30
FG		X	X		
FD				X	
FM					X
FS	X				

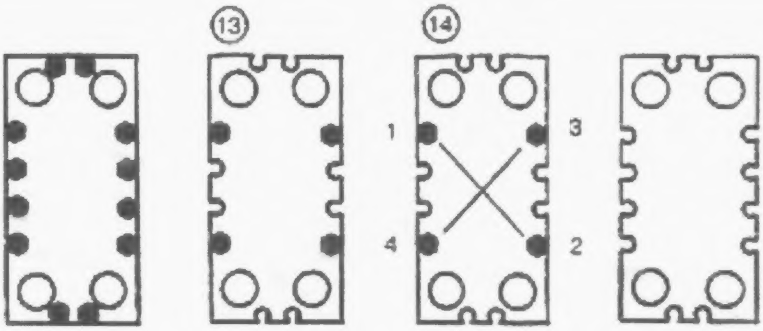
M6/M6-MFG ONLY HAS ONE BOLT TOP AND BOTTOM



	M10B M10M	M10BW		
FD	X	X		

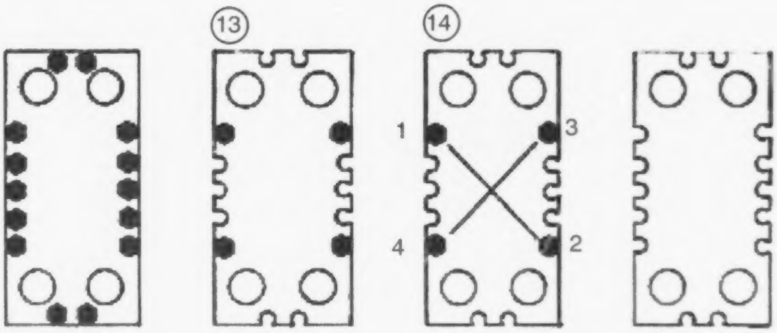


	A20B	AK20 T200	MX25B	V110
FD	X	X		
FL	X			
FG			X	X



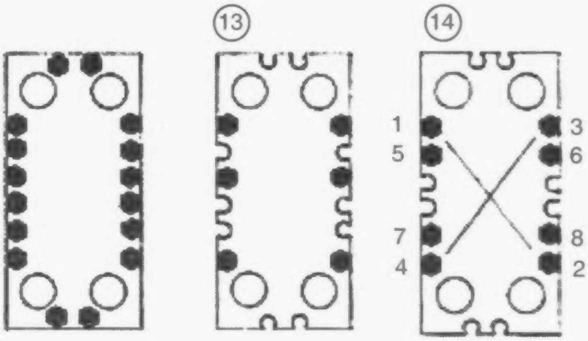
Opening

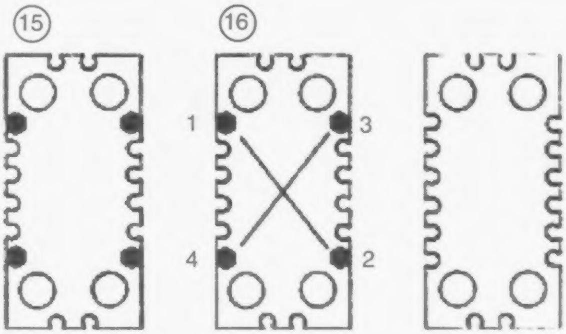
	AX30B AX30BW	V110		
FG	X			
FD		X		



	AX30B AX30BW	A35 A45	AX35	M20M	M30	MX25B	V170 V280
FG			X		X		X
FD	X			X	X	X	X
HA		X					
FS						X	

NOTE: M30-FD, MA30-FG/FD, MX25-BFS, V280-FG/FD and V170-FD have a twenty bolt or larger pattern, use this picture only as a guide. Start sequence numbers 5 and 6 at the fourth bolt down on both sides.





ORDER	BOLT NO.	TO DIM.
1	1-2-3-4-5-6	1.05A
2	1-2-3-4	1.10A
3	1-2 OR 3-4	OPENING

⑬ If bolts are fitted with bearing boxes loosen and remove them. If not fitted with bearing boxes, then follow the pictures above.

⑭ Loosen the remaining bolts, alternately and diagonally, to bring length to 1.05A.

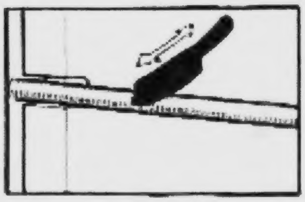
⑮ Remove bolts 5 and 6 completely.

⑯ Continue opening, alternately and diagonally.

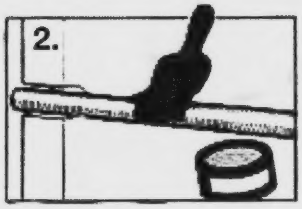
Note: Skewing of the Pressure Plate during opening must not exceed 10 mm (2 turns per bolts) across the width and 25 mm (5 turns per bolts) vertically.

Removal and insertion of plates

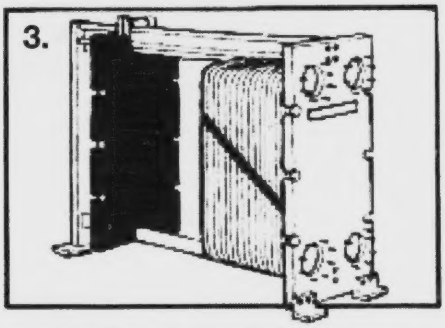
1.

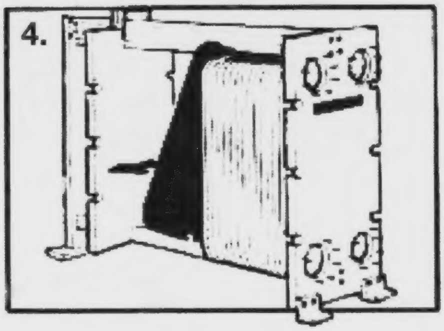


Brush the threads of the bolts clean, using a steel wire brush



Lubricate the threads with a thin layer of grease, e.g. LUBRIPLATE FGL-2 or equivalent.



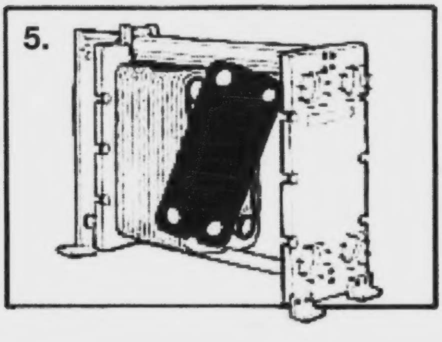


REMOVAL OF PLATES

3. Push the pressure plate against the support column.

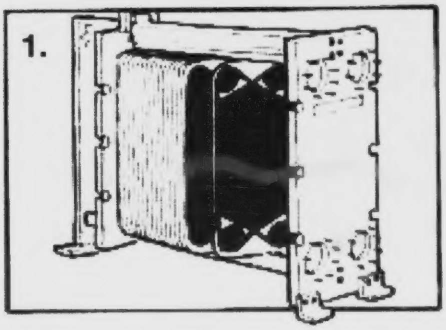
4. Remove the plates. Stack them neatly on a skid or pallet for easy transporting.

INSERTION OF PLATES

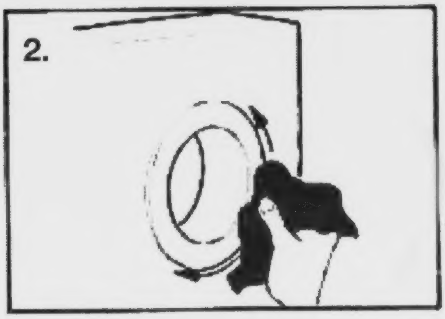


5. Hang the plates with their backs towards the pressure plate (the side without gasket).

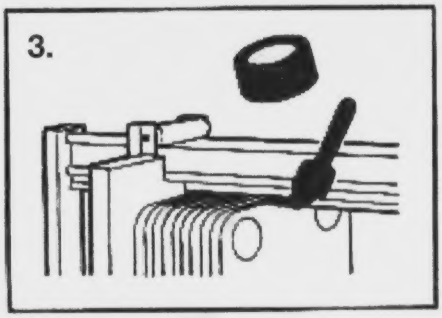
6 Closing



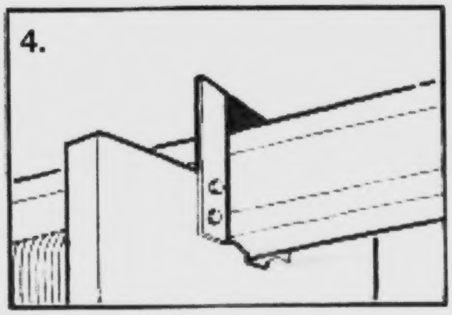
1. Check that all the sealing surfaces (i.e. surfaces in contact with the heat transfer medium) are clean.



2. Check that the ring gaskets or liners, when fitted in connections, are in position and are in good condition.

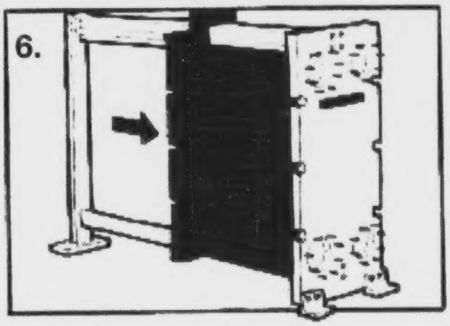


3. Clean and lubricate the sliding surfaces of the carrying bar.

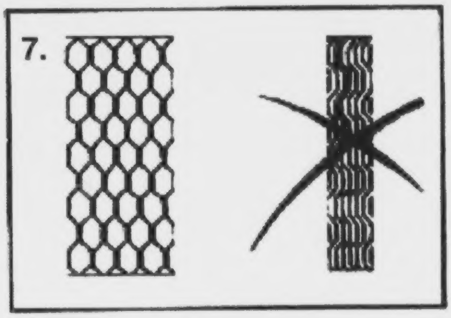


4. Inspect the pressure plate roller. Remove any debris from top surface of carrying bar.

5. Check against the drawing or flow sheet (provided with each heat exchanger) to make sure that the plates are hanging in the correct order.



6. Press the plate assembly together.



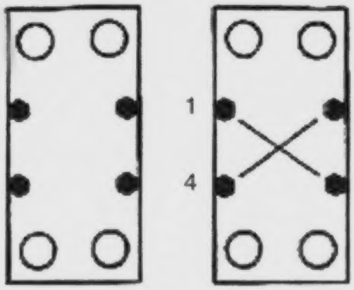
7. If the plates are correctly assembled, the edges form a "honeycomb" pattern.

If the plate pack has been marked on the outside (fig. 6) check this.

Closing

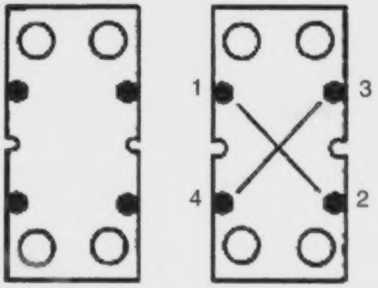
	P2	A10B	TS6-M	AM10	M10B M10M
FG	X	X	X	X	
FM					X
FD			X		

⑧ (See page 6.11) ⑪

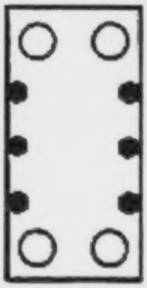


	V8	P3	V13 V20	V28	M10B M10M	M10BW M10DW	M20-M
E		X					
FD			X				
FG			X	X	X	X	
FM							X
VG	X						

⑧ (See page 6.11) ⑪

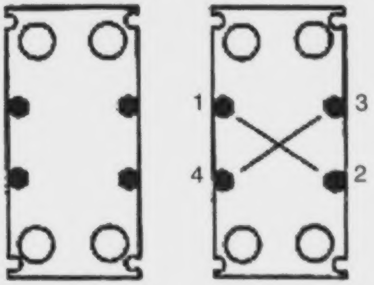


⑭ (See page 6.11)

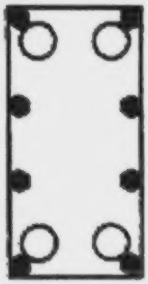


	M3	P2	P3	V28	V45
EH			X		
VG	X				
VLCH		X			
FG					X
FD				X	X

⑧ (See page 6.11) ⑪



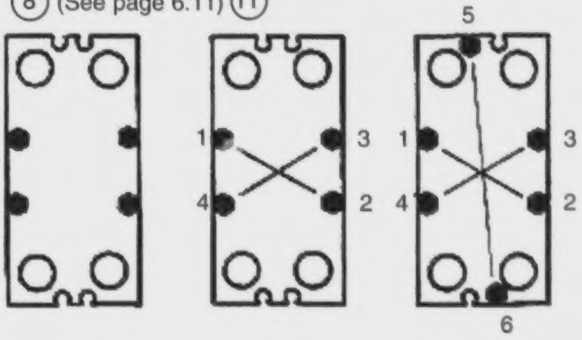
⑭ (See page 6.11)



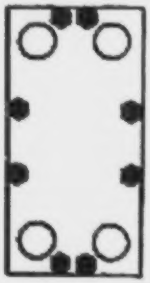
	MX25B	A15BW	A15B	TS20-M	AM20 AM20B AM20W AM20S AM20DW	M6 M6M	M15M
FG		X	X	X	X	X	X
FD		X	X				X
FL			X				
FM	X			X			X
FS				X			

M6/M6-MFG & MX25-BFM ONLY HAS ONE BOLT TOP AND BOTTOM

⑧ (See page 6.11) ⑪



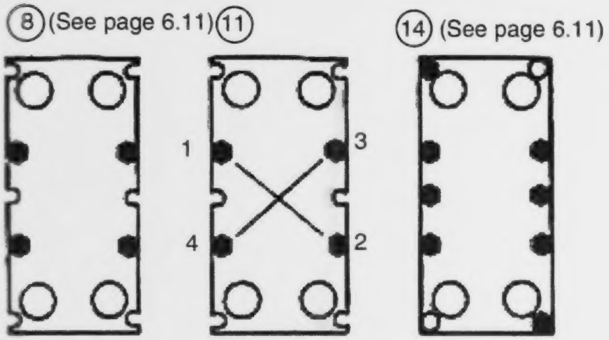
⑭ (See page 6.11)



Closing

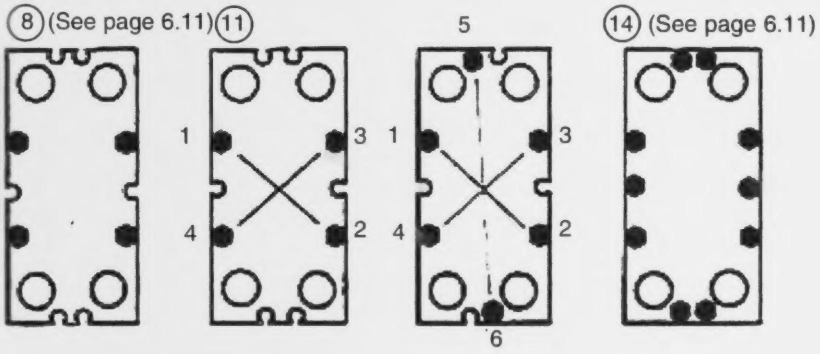
	M20-M			
FG				

M20-MFG ONLY HAS ONE BOLT TOP AND BOTTOM

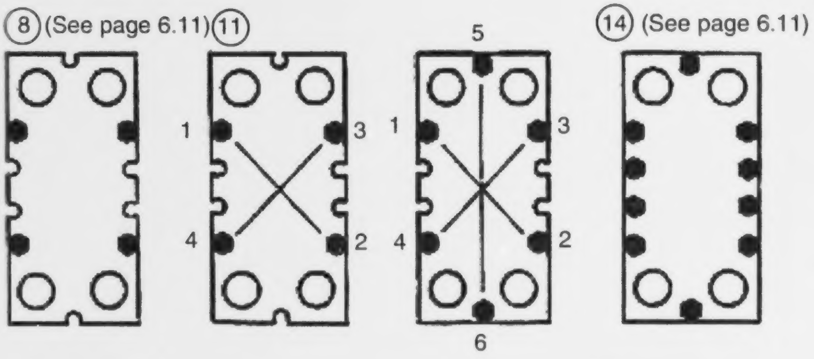

⑧ (See page 6.11)
⑪
1
3
4
2
⑭ (See page 6.11)

	M15B M15F	A20B	T200	M6 AK20 M6DW	M6M M30
FG		X	X		
FD				X	
FM					X
FS	X				

M6/M6-MFG ONLY HAS ONE BOLT TOP AND BOTTOM


⑧ (See page 6.11)
⑪
1
3
4
2
5
1
3
4
2
6
⑭ (See page 6.11)

	M10B M10M	M10BW		
FD	X	X		


⑧ (See page 6.11)
⑪
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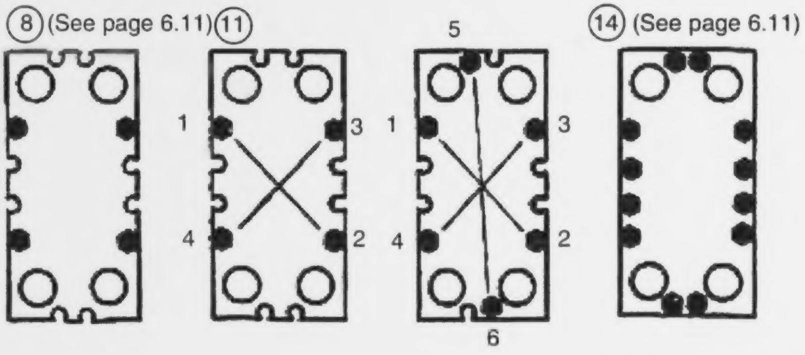
3
4
2
5
1
3
4
2
6
⑭ (See page 6.11)

	A20B	AK20 T200	MX25B	V110
FD	X	X		
FL	X			
FG			X	X


⑧ (See page 6.11)
⑪
1
3
4
2
5
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3
4
2
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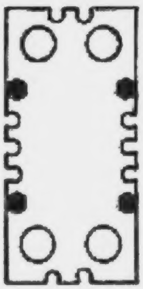
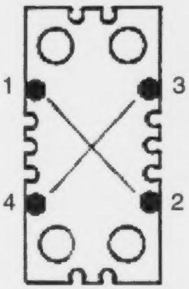
⑭ (See page 6.11)

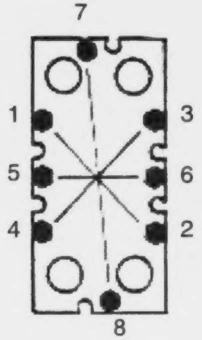
	AX30B AX30BW	V110		
FG	X			
FD		X		

⑧

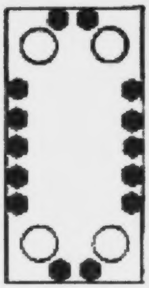


⑪





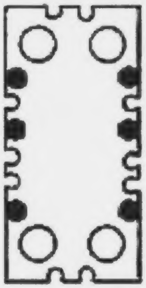
⑭



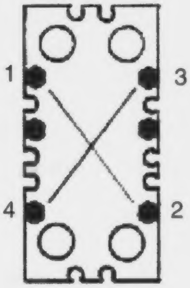
	AX30B AX30BW	A35 A45	AX35	M20M	M30	MX25B	V170 V280
FG			X		X		X
FD	X			X	X	X	X
HA		X					
FS						X	

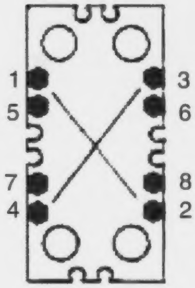
NOTE: M30-FD, MA30-FG/FD, MX25-BFS, V280-FG/FD and V170-FD have a twenty bolt or larger pattern, use this picture only as a guide. Start sequence numbers 5 and 6 at the fourth bolt down on both sides.

⑧

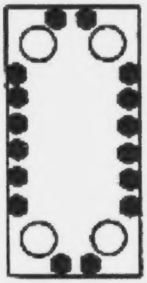


⑪





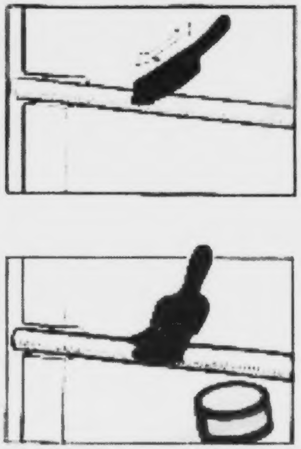
⑭



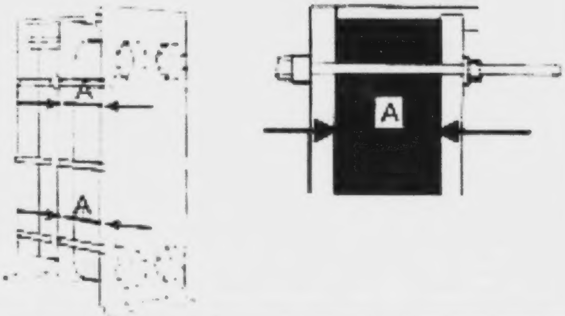
ORDER	BOLT NO.	TO DIM.
1	1-2-3-4-5-6	1.05A
2	1-2-3-4	1.10A
3	1-2 OR 3-4	OPENING

Note: See next page for closing instructions for all the models

Closing



ORDER	BOLT NO	TO DIMENSION
1	1-2 OR 3-4	1,10A
2	1-2-3-4-5-6-7-8	A



⑧ Place all the bolts that are fitted with bearing boxes in position. If not fitted with bearing boxes then follow the pictures for your specific model.

⑨ Brush the threads of the bolts clean, using a steel wire brush.

⑩ Lubricate the threads with a thin layer of grease, e.g. LUBRIPLATE FGL-2 or equivalent.

⑪ Tightening is carried out alternately and diagonally, as shown on the figure above.

⑫ Check the dimension A during tightening at the positions of the bolts that are being used. Skewing of the pressure plate during tightening must not exceed 10mm (2 turns per bolt) across the width and 25 mm (5 turns per bolt) vertically.

⑬ Nominal plate pack length A can be exceeded in exceptional cases, the tightening can be stopped at the following dimensions

Plate pack length/plat	Plate pack length
> 4 mm	A + 1%
> 3mm, < 4mm	A + 1.5%

⑭ Place the other bolts in position.

- Inspect the washers.
- When fully tightened, the bolts should all be equally tensioned.
- The difference between the plate pack lengths measured at adjacent bolts should not exceed:

  2mm when dimension A is < 1000mm

  4mm when dimension A is > 1000mm
- The plate pack length at all bolts must not differ by more than 1%
- If the unit does not seal fully, it can be tightened to the dimension A-1%.

IF DIMENSION A IS NOT REACHED WITH APPLICATION OF THE ABOVE STEPS:

- Check the number of plates and dimension A.
- Check that all the nuts and bearing boxes are running freely. If not, clean and lubricate or replace.
- Fit all the bolts, and tighten alternately.

Chlorine as growth inhibitor

Chlorine, commonly used as growth inhibitor in cooling water systems, reduces the corrosion resistance of stainless steels (including Hastelloy, Incoloy, Inconel and SMO).

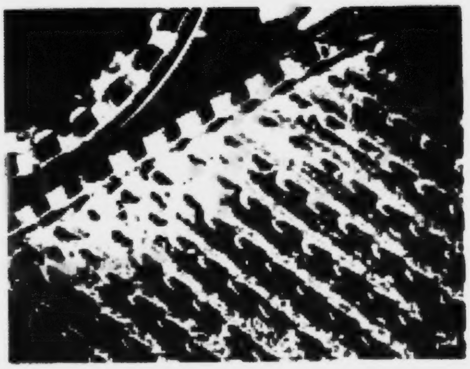
Chlorine weakens the protection layer of these steels making them more susceptible to corrosion attacks than they otherwise should be. It is a matter of time of exposure and concentration.

In every case where chlorination of non-titanium equipment cannot be avoided, ALFA LAVAL must be consulted.

Contact the following address:
ALFA LAVAL
Heat Transfer Center
5400 International Trade Drive
Richmond, VA 23231
Phone (804) 222-5300
Fax (804) 236-3276

NOTE! Titanium is not affected by chlorine.

Cleaning

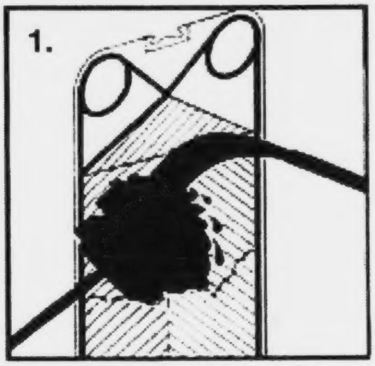


INCRUSTATION - SCALING

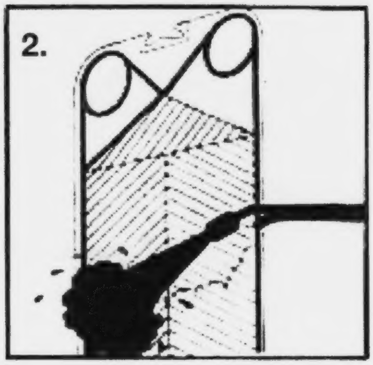
- Calcium carbonate
- Calcium sulphate
- Silicates

CLEANING

Mechanical cleaning after opening.



1. Soft brush and running water.
   NOTE! Avoid gasket damage.



2. High pressure hose.

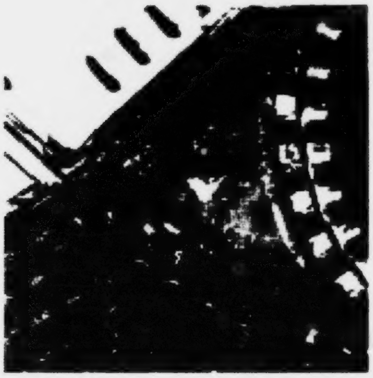
3. Chemical cleaning of opened unit by using:
   - Nitric acid
   - Sulfamic acid
   - Citric Acid
   - Phosphoric acid
   - Complexing agents (EDTA, NTA)
   - Sodium polyphosphates

Concentration max 4% by wt%
Temperature max 140° F

NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

Cleaning

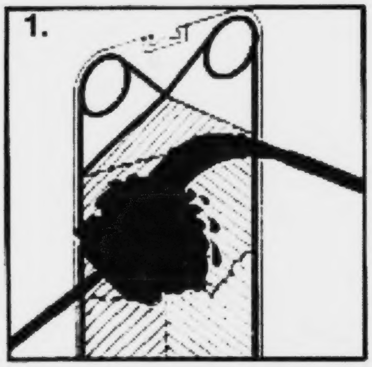


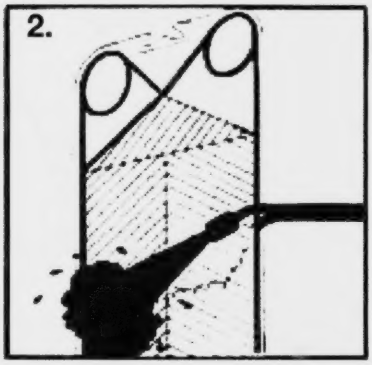
SEDIMENT

- Corrosion products
- Metal Oxides
- Silt
- Alumina
- Diatomic organisms and their excrement of various colors.

CLEANING

Mechanical cleaning after opening.





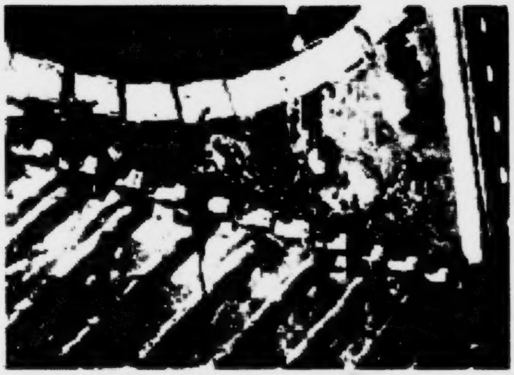
1. Soft brush and running water. NOTE! Avoid gasket damage.
2. High pressure hose.
3. Chemical cleaning of opened unit by using:
   - Nitric acid
   - Sulfamic acid
   - Citric Acid
   - Phosphoric acid
   - Complexing agents (EDTA, NTA)
   - Sodium polyphosphates
4. The addition of surfactants can improve cleaning effect.

Concentration max 4% by wt%
Temperature max 140° F

NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

Cleaning

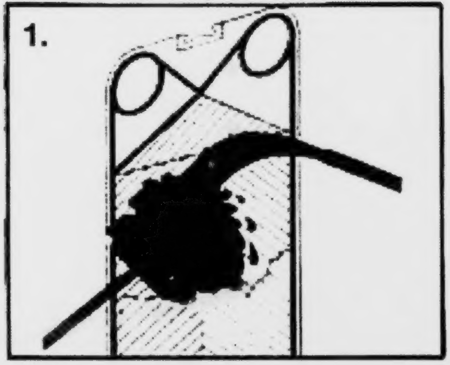


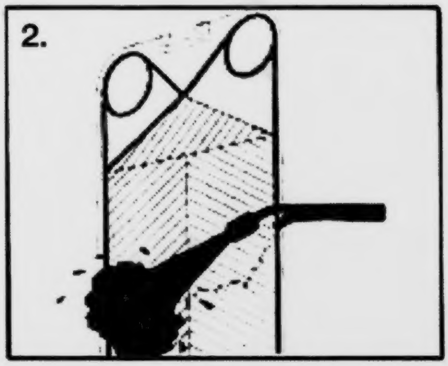
GROSS FOULING

- Seaweeds
- Wood chips/fibers
- Mussels
- Barnacles

CLEANING: NOTE: BACKFLUSHING OF THE UNOPENED HEAT EXCHANGER CAN SOMETIMES BE SUFFICIENTLY EFFECTIVE.

Mechanical cleaning after opening.



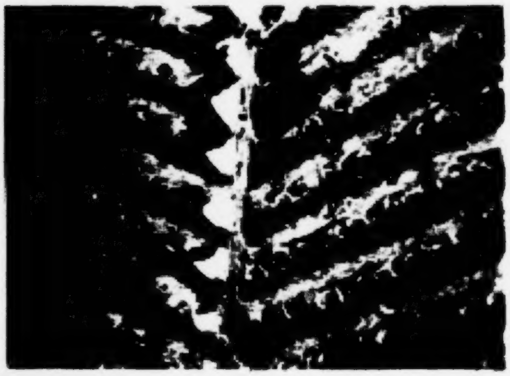


1. Soft brush and running water.
   NOTE! Avoid gasket damage.
2. High pressure hose.

NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

Cleaning

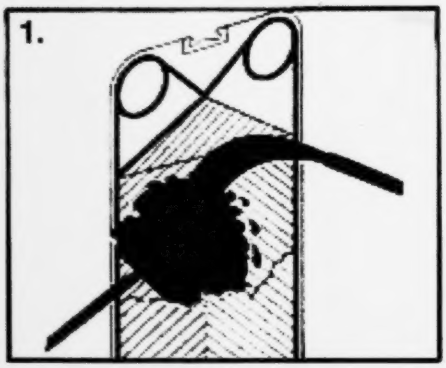


BIOLOGICAL GROWTH - SLIME

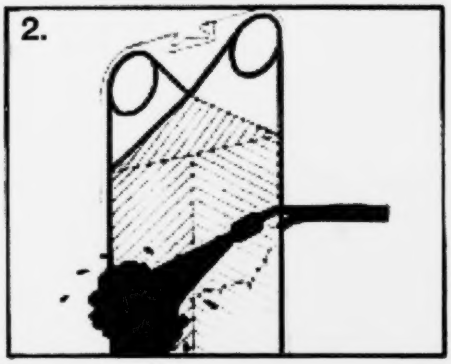
- Bacteria
- Nematodes
- Protozoa

CLEANING

Mechanical cleaning after opening.



1. Soft brush and running water.
   NOTE! Avoid gasket damage.



2. High pressure hose.

3. Chemical cleaning of opened unit by using:
   - Nitric acid
   - Sulfamic acid
   - Citric Acid
   - Phosphoric acid
   - Complexing agents (EDTA, NTA)
   - Sodium polyphosphates

Concentration max 4% by wt%
Temperature max 140° F

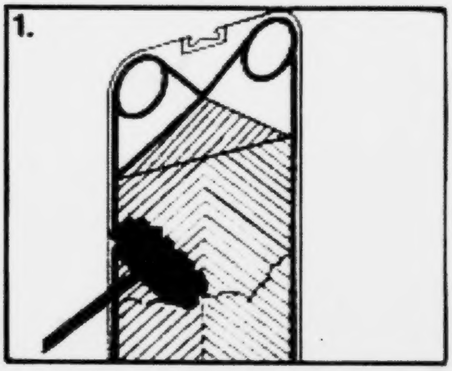
NOTE!
Under no circumstances should HYDROCHLORIC ACID be used with STAINLESS STEEL PLATES and under no circumstances should HYDROFLUORIC ACID be used with TITANIUM PLATES. Water of more than 300 ppm Chlorine may not be used for the preparation of cleaning solutions.

It is very important that carrying bars and support columns made of aluminum are protected against chemicals.

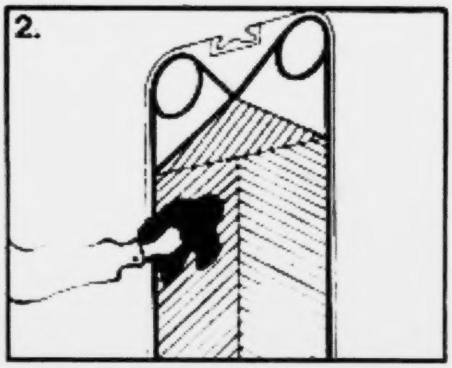
- Oil residues
- Asphalt
- Fats

CLEANING

Mechanical cleaning after opening.



1. Hydrocarbon-based deposits may be removed by using a soft brush and a PARAFFINIC or NAPHTHA-BASED solvent (e.g. KEROSENE).



2. Dry with a cloth or rinse with water.

NOTE!
Gaskets in natural, butyl and EPDM rubber swell in these media.

Contact time should be limited to 0.5 hour.

THE FOLLOWING SOLVENTS SHOULD NOT BE USED

- Ketones (e.g. Acetone, Methyletylketone, Methylisobutylketone)
- Esters (e.g. Ethylacetate, Butylacetate)
- Halogenated hydrocarbons (e.g. Chlorothene, Carbon tetrachloride, Freons)
- Aromatics (e.g. Benzene, Toluene)

Regasketing

ALFA LAVAL has two types of glue for field repairs - GC11 and GC8 for repairs and exchange of gaskets in plates. A special glue is recommended for viton and silicone gaskets.

GC11

- A two-component, cold curing epoxy glue which gives a strong joint for higher temperatures.
- Future removal of gaskets usually requires heating or freezing of the joint.
- The shelf life is limited to approx. 1 year when stored at room temperature but can be prolonged when kept in a refrigerator.

GC8

- A single-component rubber-based solvent adhesive.
- Is normally used for repair work in an uncured condition.
- Can be used for operating temperatures below 200 F
- For operating temperatures above 200° F and oil coolers/heaters, the glued joints should be cured at 200° F for one hour.
- Future removal of the gasket can usually be carried out without heating of the cement joint.
- The storage life at room temperature is about two years. This period can be extended after checking the glue.

SEPARATE GLUING INSTRUCTIONS WILL BE
DELIVERED TOGETHER WITH THE GLUE.

ALFA LAVAL RECONDITIONING SERVICE

In addition to supplying genuine gaskets for your plate heat exchangers, we are able to provide a "SPECIALIZED PLATE RECONDITIONING SERVICE" to quickly and efficiently meet your service requirements.

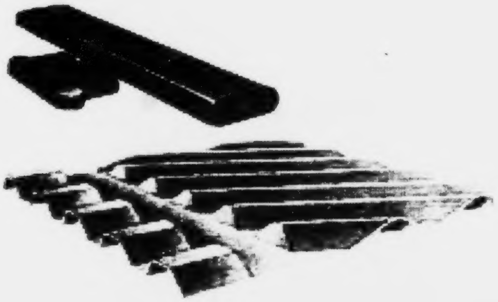
Our reconditioning service includes a liquid nitrogen debonding process with chemical cleaning, crack detection and regasketing using a special epoxy/phenolic resin adhesive.

This regasketing process requires special oven curing of the cement to ensure the strongest possible bond strength between plate and gasket, similar to the process used during manufacture. This is one reason why our service is guaranteed.

In most cases our reconditioning service has proved more economical and much faster when compared with on-site regasketing methods.

For further details, please contact your local ALFA LAVAL REPRESENTATIVE.
(See Section 1)

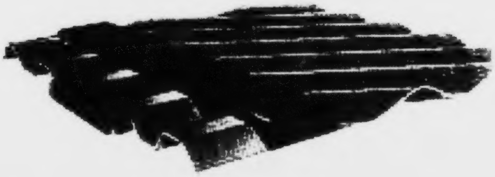
The Clip-on gasket - a glue-free gasket system



The Clip-on gasket is attached to the plate by two gasket prongs which slip under the edge of the plate to hold the gasket securely in alignment in the gasket groove.

The prongs are situated at regular intervals around the periphery of the plate.

When the plate heat exchanger is then assembled and tightened, the gasket provides a tight seal around the plate.



The Clip-on gasket in the gasket groove.

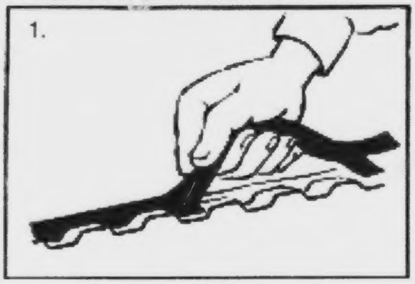
NOTE!

Before closing of the equipment: Check that the two gasket prongs are in correct position.

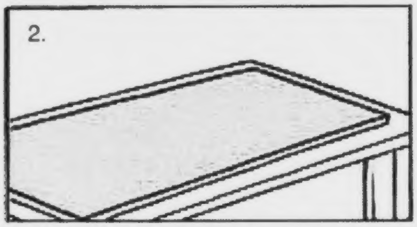
Regasketing of Snap-On Gaskets

THE PROCEDURES (2-7) ARE NOT NECESSARY FOR DOING A SMALL QUANTITY OF PLATES. THESE PROCEDURES WILL INCREASE SPEED OF REGASKETING OF LARGE QUANTITIES OF PLATES.

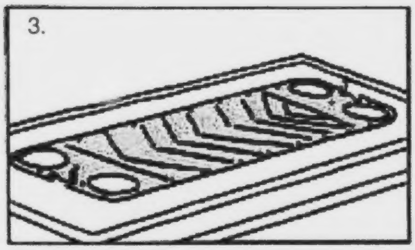
PREPARATORY PROCEDURES



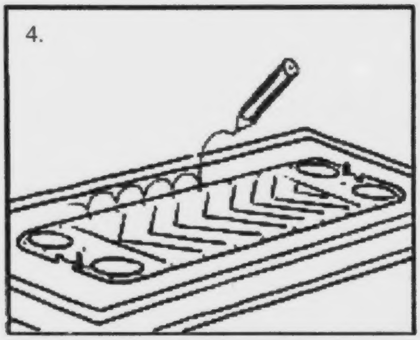
1. Pull the old gasket off the plate and clean the groove, if necessary.



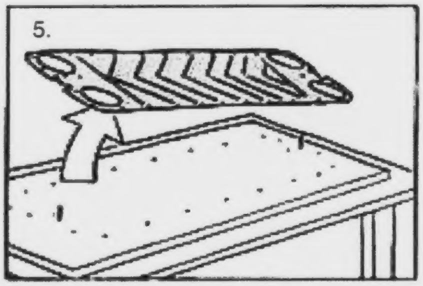
2. Place a flat sheet of plywood (somewhat larger than the PHE plate) on the table.



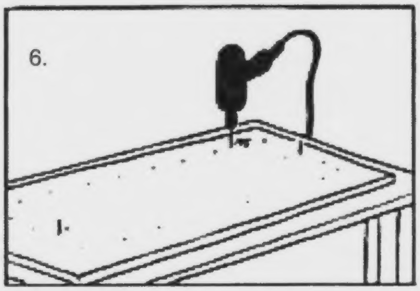
3. Place the PHE plate on the board with gasket groove upwards and fix firmly. Placing cylindrical pins in the plank at the carrying bar slots.



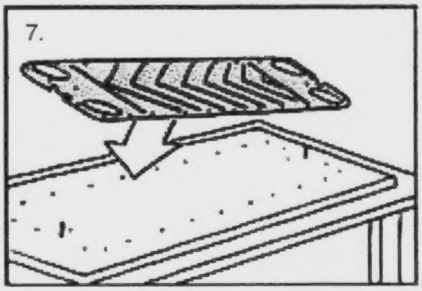
4. Make marks in the plank at all locations for gasket "snap-on".



5. Remove the plate.



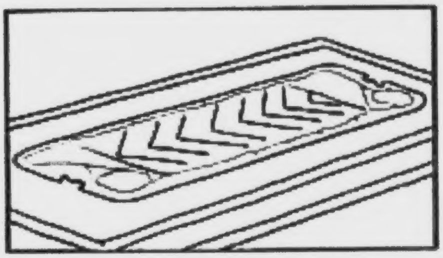
6. Drill holes approx. 7mm dia and 10 mm deep in the plank at the marked spots. The plank is now a practical tool for regasketing of larger numbers of plates.



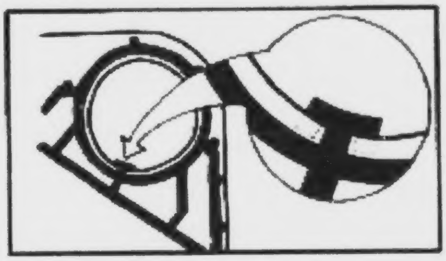
7. Replace PHE plate on the board in exactly the same location as at 3 above.

7 Regasketing of Snap-On Gaskets

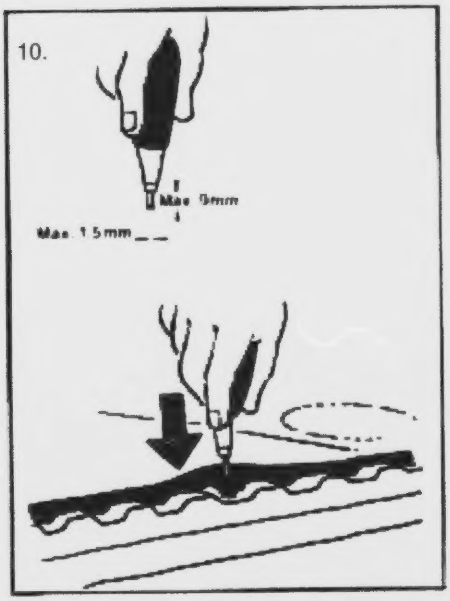
FASTENING OF THE "SNAP-ON" GASKET



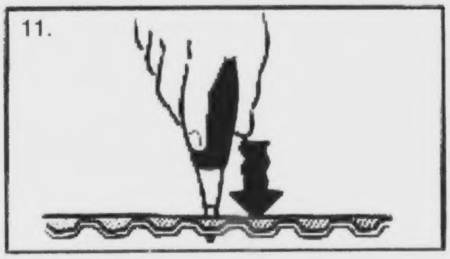
8. Place the gasket, with the "snap-on" projections downwards, in the gasket groove.



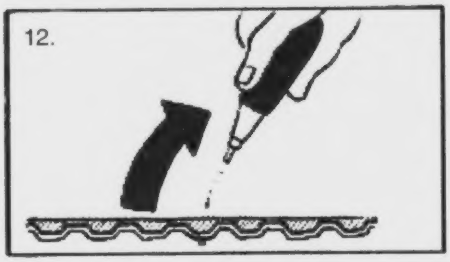
9. Place the ring gaskets in the groove and fix them with the T-flap.



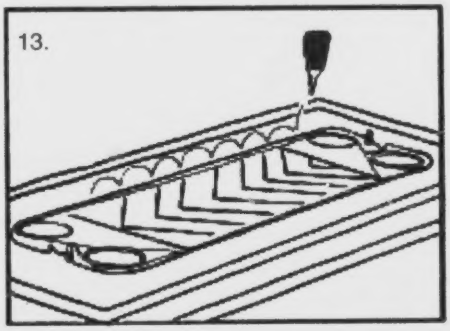
10. Insert the tool point into the recess in the projection.



11. Push the projection through the hole in the plate.



12. Remove the tool point, and the projection is now "snapped on".

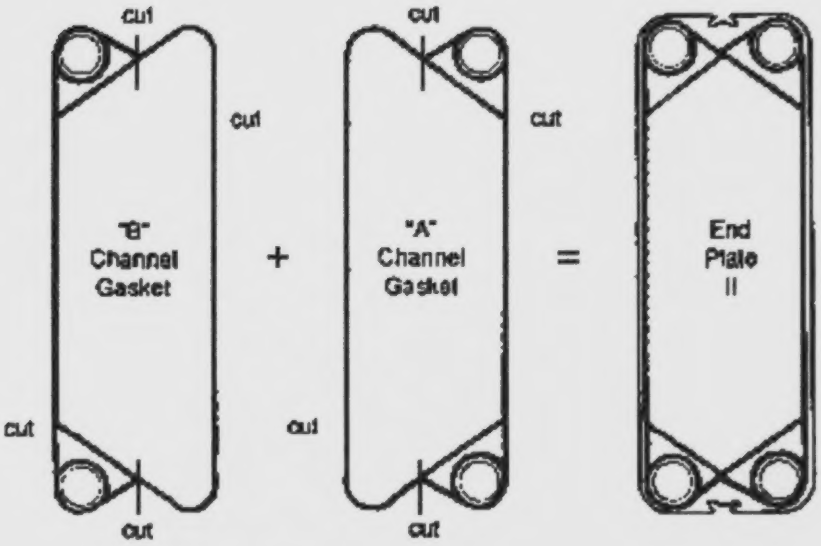


13. Repeat for all projections, and the gasket is "snapped on".

NOTE!
BEFORE CLOSING OF THE EQUIPMENT: CHECK THAT THE T-FLAPS ARE IN CORRECT POSITION.

PARALLEL FLOW UNITS

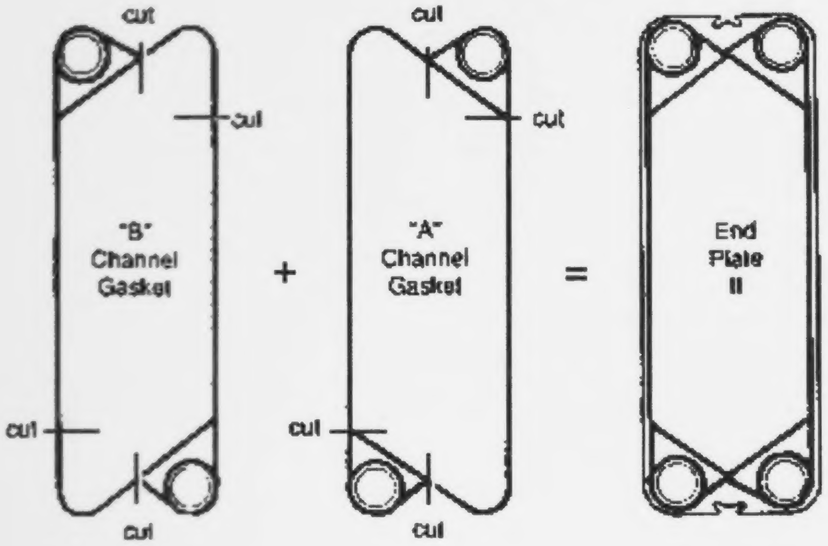
The End Plate II Gasket is formed by cutting (2) channel gaskets (as shown below) and gluing the gaskets to the first plate.


cut
cut
"B" Channel Gasket
cut
cut
+
cut
cut
"A" Channel Gasket
cut
cut
=
End Plate II

The (2) half channel gaskets should be glued to the end plate with GC-8 glue: or double sided tape (GC-1). The (4) port gasket areas are critical because these gaskets will be in contact with the process fluids.

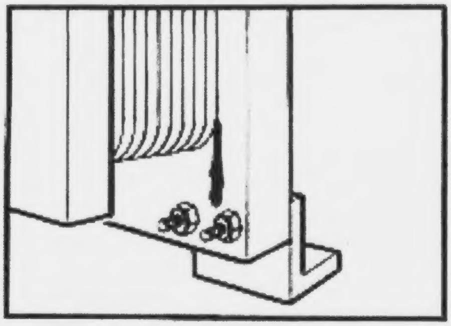
DIAGONAL FLOW UNITS

The End Plate II Gasket is formed by cutting (2) channel gaskets (as shown below) and gluing the gaskets to the first plate.


cut
cut
cut
cut
"B" Channel Gasket
+
cut
cut
cut
cut
"A" Channel Gasket
=
End Plate II

The (4) parts of the channel gaskets should be glued to the end plate with GC-8 glue: or double sided tape (GC-1). The (4) port gasket areas are critical because these gaskets will be in contact with the process fluids.

Fault detection



SYMPTOM

LEAKAGE between plates and frame.

ACTION

Mark with a felt tip or similar marker, mark the area where the leakage seems to be, and open the heat exchanger

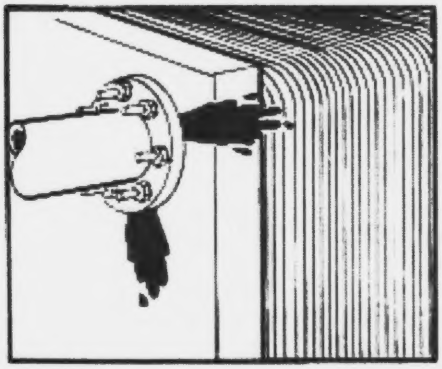
1. Investigate the gasket condition of the end plate and the connection if applicable, look for dislocation, foreign objects, scars and other damage to the gasket surfaces.
2. Check the surface of the pressure plate for unevenness, foreign objects sticking to it, etc. that might spoil the joint between the gasket and the adjacent surface.
3. Check the plate itself for cracks or holes.

CORRECTIONS

1.
   - Relocate gasket.
   - remove foreign matter.
   - replace connection lining if applicable.

   Remove anything disturbing the joint between gasket and pressure plate surface.

   A perforated end plate must be replaced.



SYMPTOM

LEAKAGE between flange and frame.

ACTION

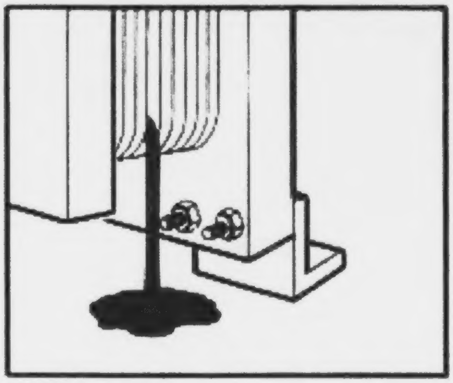
1. Disconnect the flange, and look for misalignment between flange and connection, dislocated or damaged gasket, foreign objects on the surface of the gasket or the flange.

CORRECTIONS

1.
   - Rearrange the pipe in order to eliminate stress and to correct alignment.
   - relocate gasket
   - replace damaged gasket
   - replace connection lining if applicable
   - remove foreign matter from flange and gasket
   - reassemble, taking care to avoid misalignment

8 Fault detection

NOTE: On a Plate Heat Exchanger specially designed for high temperature duties, extreme and sudden temperature drops may sometimes cause a temporary leakage. A typical example is a sudden shutting-off of the hot medium flow. The heat exchanger will normally seal again, as soon as the temperatures of the equipment have stabilized.



SYMPTOM

LEAKAGE between plates to the outside.

ACTION	CORRECTIONS
Mark the leakage area with a felt tip marker on the two plates next to the leakage, check and note the length of the plate pack between inside frame plate and inside pressure plate, and then open the heat exchanger.	
1. Check for loose, dislocated or damaged gasket.	1. • Relocate gasket. • Re-cement loose gasket, if applicable. • Replace damaged gasket.
2. Check for plate damage in the area, and also check plate pack length against the drawing to see if possible plate or gasket damage could be caused by overtightening of the plate pack, or if the leakage itself may simply be caused by insufficient tightening.	2. A damaged plate must in most cases be taken out for repair or replacement. If it is a regular plate with 4 holes: take the damaged plate and the 4-hole plate just in front or just behind it out of the plate pack. The heat exchanger can now be reassembled and put back in service PROVIDED THE PLATE PACK IS TIGHTENED TO A NEW MEASUREMENT, WHICH IS EQUAL TO THE ONE ON THE DRAWING, REDUCED BY TWO TIMES THE SPACE REQUIRED PER PLATE. CONTACT ALFA LAVAL FOR ASSISTANCE IN THE RECALCULATION IF NECESSARY. The small reduction of the heat transfer area is normally of no importance, at least not for a short period of time. • Insufficient tightening must be corrected - see the drawing.
3. Check hanger recess at both plate ends for deformations, which could cause misalignment between the plates.	3. Damaged hanger recesses must be repaired if possible, or the plate replaced. For temporary arrangement with reduced number of plates - see paragraph 2 above.
4. Make sure that the plates are hanging correctly as A-B-A (see SECTION 4A or 4B).	4. Incorrect sequence of plates must be corrected (A-B-A-B-..). MAKE SURE THAT NO PLATE HAS BEEN DAMAGED, BEFORE REASSEMBLING THE PLATE PACK!
5. Check for perforation of the plate (corrosion).	5. Perforated plates must be replaced. For temporary solution, see paragraph 2.

SYMPTOM

LEAKAGE between plates.

ACTION	CORRECTIONS
1. Check that the piping is connected to the heat exchanger at correct locations.	1. Relocate piping to correct connections.
2. Open the lower connection on one side, raise pressure on the other side and by looking into the open connection try to detect any liquid from the pressurized side leaking in, and if so - approximately how far into the plate pack the leakage is located. If no leakage is detected, the reason for the mixing of media must be sought elsewhere. (see paragraph 5).	
3. If a leakage was detected, note the position of the leakage along the plate pack and then open the plate heat exchanger.	
4. Before starting on the plates themselves, check that the corner areas between the ring and the field gaskets are clear, that the leakage slots are open. This ensures that any leakage is out of the plate heat exchanger and is to atmosphere. Therefore no pressure can build up to force the media across the gasket sealing off the other liquid.	4. All deposits or material which can block the free exit from the area must be removed. If the leak channels of the gasket have been destroyed, they must be reopened with a suitable tool, or the gasket replaced.
5. If it has not been possible to locate the leakage as described in par. 2 above, it will be necessary to check each single plate for possible perforations, using any of the following methods: • put a strong light behind the plate and watch for light coming through fine holes or cracks. • use a magnifying glass to check suspect area. • use a chemical penetrant, after having cleaned the plates well.	5. Plates with holes must be replaced. The PHE may be temporarily operated with a reduced number of plates. See "LEAKAGE between plates to the outside".

SYMPTOM

PRESSURE DROP PROBLEMS,

Pressure drop has increased

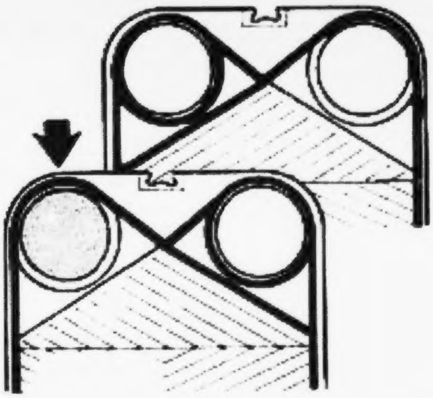
ACTION	CORRECTIONS
Check that all valves are open including non return valves.	
Measure the pressure just before and just after the heat exchanger, and the flow rate. For viscous media a membrane manometer with a diameter of at least 30 millimeters should be used. Measure or estimate the flow rate if possible. A bucket and a watch showing seconds may be sufficient for small flow rates. For larger flow rates, some type of flowmeter is required. Compare the pressure drop observed with the one specified for the actual flow rate. (see plate print out)	
1. If the pressure drop is higher than specified, the temperature program should also be checked:	1. See next paragraph.
1.1 If the thermometer readings correspond to those specified, the heat transfer surface is probably clean enough, but the inlet to the heat exchanger may be clogged by some objects.	1.1 Open the PHE and take out whatever is clogging the passage, or use the back-flush system - if there is one - to rinse out the cloggings.
1.2 If the thermometer readings are NOT corresponding to those specified, heat transfer is obviously dropping below specifications, because of deposits on the heat transfer surface, which at the same time also increase the pressure drop, since the passage becomes narrower.	1.2 If a "cleaning-in-place" system is available, follow the instruction and use it to wash out the deposits. If not, open the PHE and clean the plates.
2. If the pressure drop corresponds to the specifications, there is no need for any action.	2. See pump instruction manual.
3. If the pressure drop is lower than specified, the pump capacity is too small or the observation is wrong.	

SYMPTOM: HEAT TRANSFER PROBLEMS

The heat transfer capacity is dropping

ACTION	CORRECTIONS
Measure temperatures at inlet and outlets and also flow rates on both media, if possible. At least on one of the media, both temperatures and the flow rate must be measured. Check to see if the transferred amount of heat energy corresponds to the specifications. If great precision is important, it will be necessary to use laboratory thermometers with an accuracy of 0.2 degrees Fahrenheit, and also to use the best equipment available for flow measurements.	If the heat transfer capacity of the equipment has dropped below specified values, the heat transfer surface must be cleaned. Either use the "cleaning-in-place" arrangement if provided or open the heat exchanger for visual inspection and manual cleaning. NOTE: Contact the Alfa Laval Sales & Service Division for CIP recommendations (See Section 1).

9 Supplementary Parts



THE PARTITION PLATE - for special cases only.

If for instance, the thermal program requires that at least one of the media is to flow in more than one group through the plate package, there will be heat transfer plates with fewer than 4 holes.

To prevent the thin metal collapsing under the differential pressure, un-punched corners require extra support.

The extra support is provided by a partition plate - approximately the size of a channel plate - made of about 1/4" - 3/4" thick plate material with lined holes where a free passage is required.

The partition plate is suspended from the carrying bar. Where partition plates are required, in units with 8" ports or larger, there will be one at every turning point in a multi-grouped plate package.

Example only

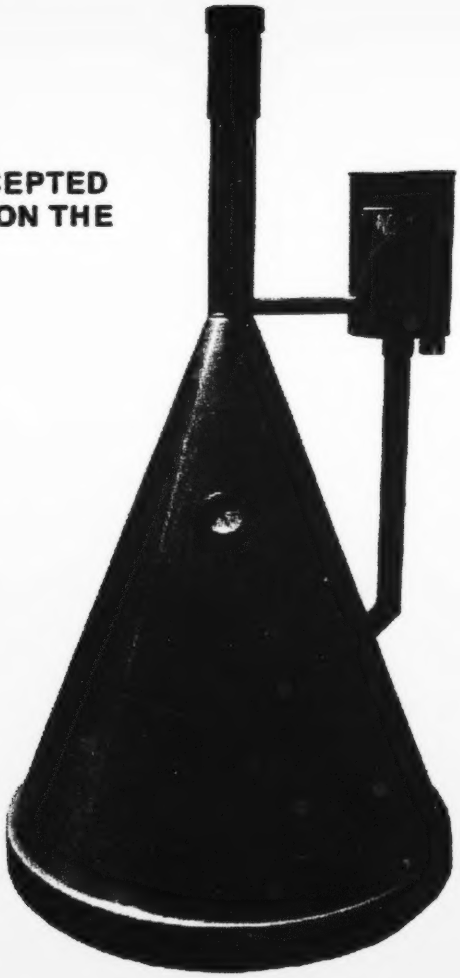
Appendix III

Distillation Unit Specifications

TP RECEIVING CAN

MODEL TP-100

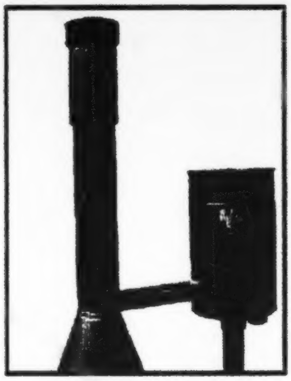
MOST WIDELY ACCEPTED SEPARATING CAN ON THE MARKET



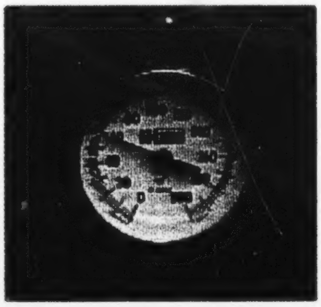
NEWHOUSE
MANUFACTURING COMPANY

1048 N. 6th STREET – REDMOND, OR 97756
PHONE: (541)-548-1055 FAX: (541)-548-4144 TOLL FREE NUMBER 1-800-587-1055
Web Site: www.newhouse-mfg.com E-mail: info@newhouse-mfg.com

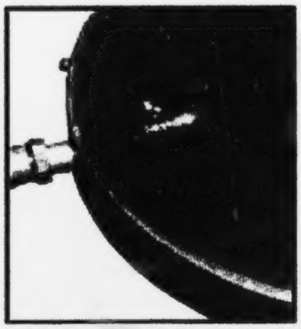
ALL ALUMINUM CONSTRUCTED



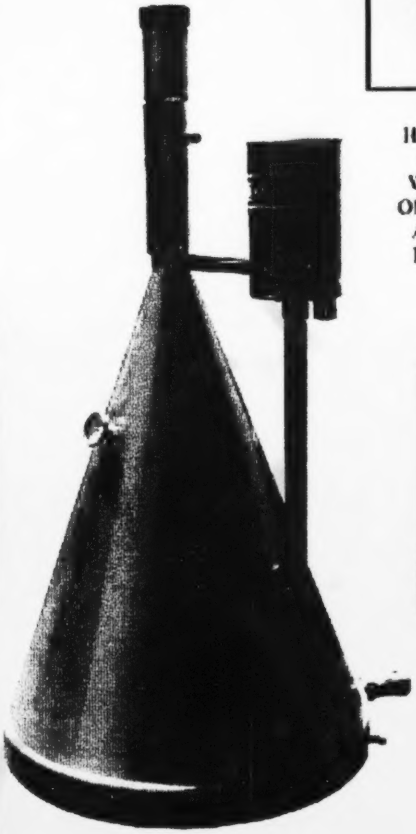
SIGHT GAUGE
SEALED INCANDESCENT LIGHT FIXTURE WITH SWITCH, ILLUMINATES OIL LEVEL AND OIL MOVEMENT.

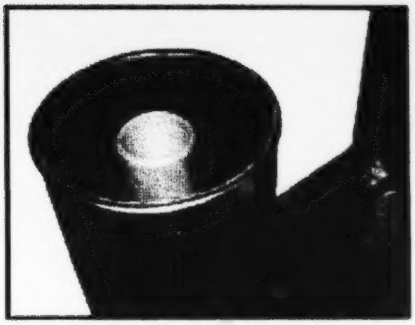


BUILT-IN GAUGE
FOR SETTING AND INSPECTING TEMPERATURE.

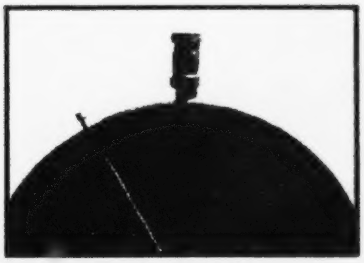


BUILT-IN STEAM NOZZLE FOR PREHEATING AND CLEANING.





WASTE WATER DISCHARGE
HAS AN ADJUSTABLE THREADED SLEEVE THAT CONTROLS THE WATER LEVEL IN SIGHT GAUGE. ONCE ADJUSTED PROPERLY WILL AUTOMATICALLY KEEP WATER FROM DISCHARGING THROUGH OIL OUTLET.



UNDER SIDE
SHOWING DRAIN PIPE, INPUT COMPRESSION COUPLER FOR E-Z HOOK UP AND INSPECTION PLATE FOR SERVICE OF STAINLESS STEEL PACKING.

SPECIFICATIONS

OVER ALL HEIGHT	72 INCHES
DIAMETER	37 INCHES
WEIGHT	50 LBS

Appendix IV

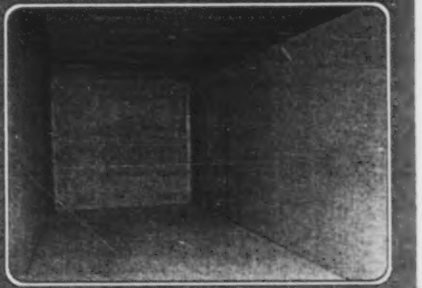
Trailer Specifications

7' Wide Cargo

Models

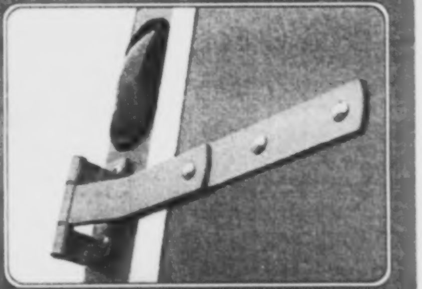
CHT 35-714-72, CHT 37-716-72
CHT 60-716-72

Features



Interior Finish

The interior is designed to create smooth flush fittings between the interior plywood and the RoyalCargo designed Structural Roof Cove*.



Door Hinges

Galvanized, powder coated, heavy-duty wrap around hinges are riveted to the trailer. Each unit is prepped and painted before the installation of hardware providing a clean finish and increased rust protection.

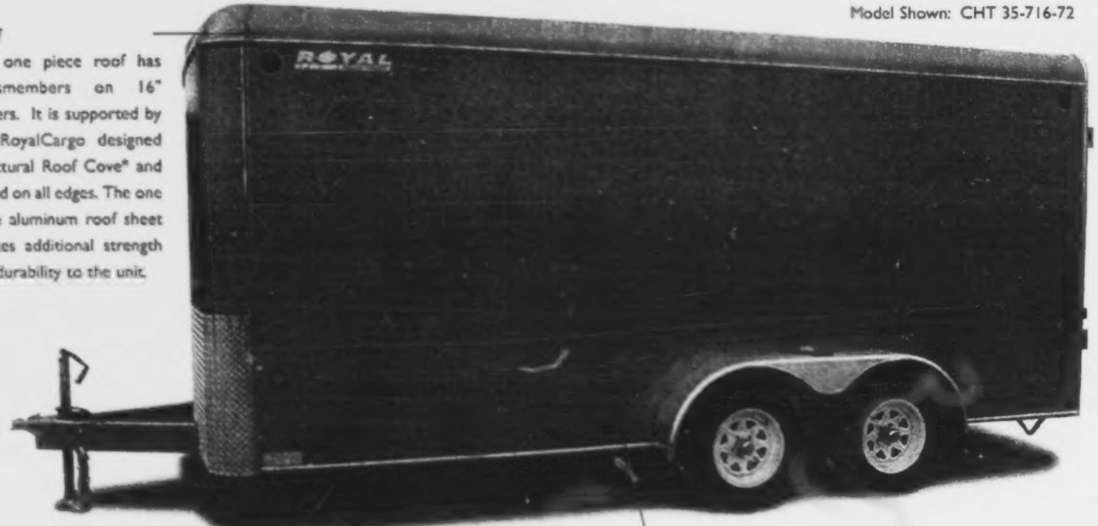
Excellent Worth

A 7' wide cargo provides excellent worth for your business every day. The 7' wide cargo is the trailer of choice for the landscaper, contractor, and a variety of other commercial users. Heavy-duty structural design and rubber ride axles allow the trailer to work hard, safely. The barn style rear doors provide easy loading and unloading access, and the plywood lining protects and strengthens the interior. Add options such as a side door, swing down stabilizers, and extra lighting to increase utility and match your needs.

Model Shown: CHT 35-716-72

Roof

The one piece roof has crossmembers on 16" centers. It is supported by the RoyalCargo designed Structural Roof Cove* and sealed on all edges. The one piece aluminum roof sheet creates additional strength and durability to the unit.



Protective Undercoat

All RoyalCargo trailers receive an automotive quality protective undercoat. This undercoating protects the plywood floor from road wear and tear, as well as completes the seal of the unit allowing no chance for moisture to creep into your load.

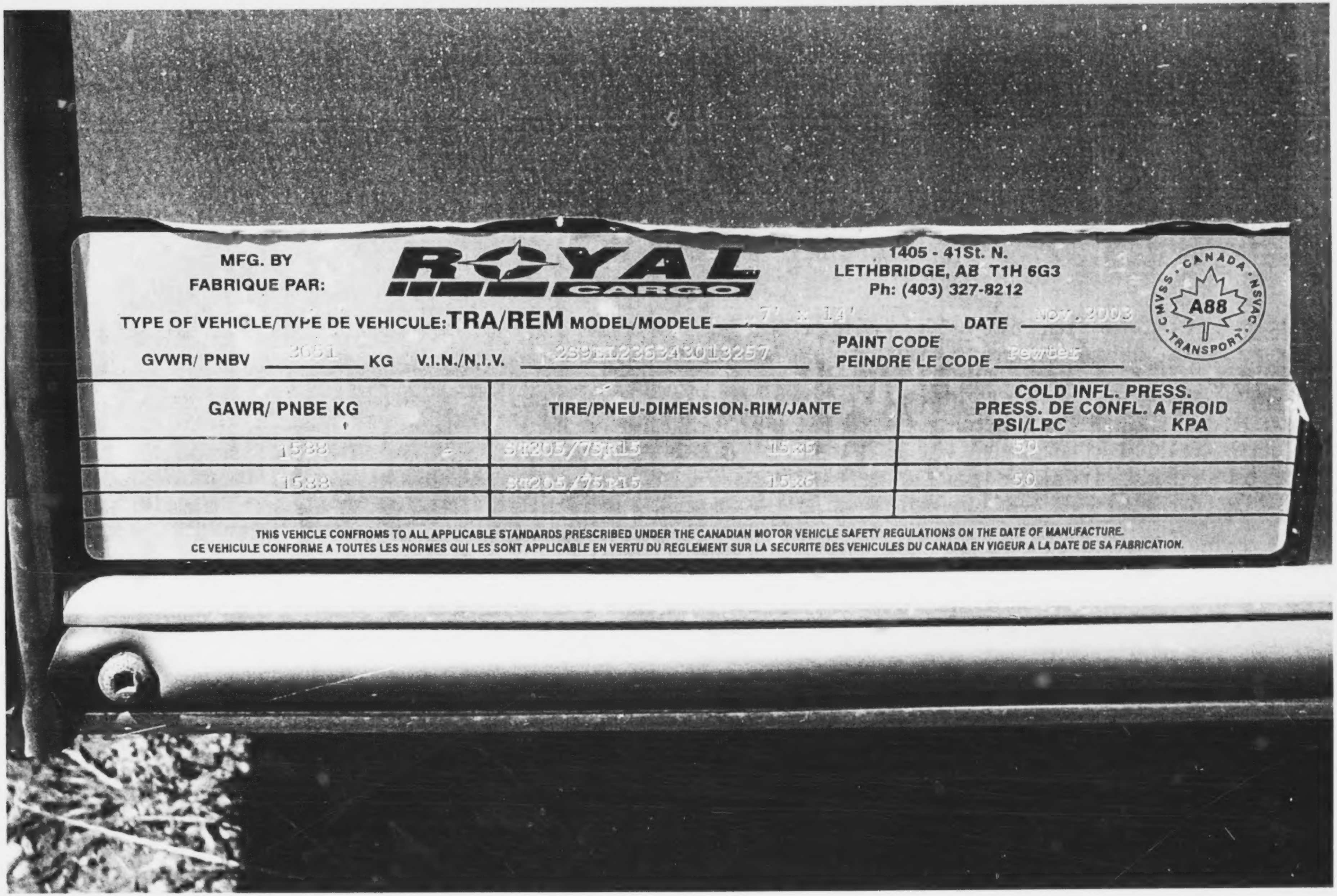
Rivetless Exterior

All RoyalCargo Trailers have smooth aluminum rivetless exteriors, ideal for placement of trailer graphic film such as decals and company logos. The sheets are fastened to the frame using technology which seals the sheets to the frame yet cushions at the same time. With the seams being sealed and cushioned, vibration damage from rattling rivets and screws is non-existent; the chance of leakage is eliminated.

* Patent Pending. The RoyalCargo Structural Roof cove provides additional strength to the walls and roof of the trailer.

Model	Interior			Overall			Rear Door Opening		Platform Height	Ball Height	Curb Weight	Options
	Height	Width	Length	Height	Width	Length	Height	Width				
CHT 35-714-72	72"	81"	167"	103"	102"	215"	73.5"	74"	21"	18.5"	2200 lb	V, B, L, RS, A15
CHT 35-716-72	72"	81"	191"	103"	102"	239"	73.5"	74"	21"	18.5"	2400 lb	V, B, L, RS, A15
CHT 60-716-72	72"	81"	191"	103"	102"	239"	73.5"	74"	21"	18.5"	2600 lb	V, B, L, RS, A16

ROYAL CARGO



MFG. BY
FABRIQUE PAR:

ROYAL CARGO

1405 - 41St. N.
LETHBRIDGE, AB T1H 6G3
Ph: (403) 327-8212

CANADA · NSVAC · TRANSPORT · CMVSS
A88

TYPE OF VEHICLE/TYPE DE VEHICULE: **TRA/REM** MODEL/MODELE 7' x 14' DATE NOV.2003

GVWR/ PNBV 3051 KG V.I.N./N.I.V. 2S9LL236343013257 PAINT CODE PEINDRE LE CODE Pewter

GAWR/ PNBE KG	TIRE/PNEU-DIMENSION-RIM/JANTE		COLD INFL. PRESS. PRESS. DE CONFL. A FROID PSI/LPC	KPA
1588	ST205/75R15	15x6	50	
1588	ST205/75R15	15x6	50	

THIS VEHICLE CONFROMS TO ALL APPLICABLE STANDARDS PRESCRIBED UNDER THE CANADIAN MOTOR VEHICLE SAFETY REGULATIONS ON THE DATE OF MANUFACTURE.
CE VEHICULE CONFORME A TOUTES LES NORMES QUI LES SONT APPLICABLE EN VERTU DU REGLEMENT SUR LA SECURITE DES VEHICULES DU CANADA EN VIGEUR A LA DATE DE SA FABRICATION.

Created on 6/18/2007
Updated 8/10/2007

5005E – Commissioning Notes

1. **June 11, 2007 – Boiler Steam Valve Position vs Condensate Temperature**
   a. Decided on the positioning reference for the Boiler Steam Valve – Using a clock and noting closed position is at 7:30 and each 1/8 increment is 1.5 hours.
   b. Cold waterflow through the Condenser was fully open during flowrate testing
   c. Observed that the water holding tank overflow could not keep up to the inflow that was powered by the city water pressure. The tank overflowed out the top cap. Temporary fix in place for commissioning by connecting the overflow directly to a hose and running outside the trailer.
   d. Stabilized operation for 2.5 minutes before taking temperature readings. Average reading was used over a 2 minute interval.
   e. Boiler system set at 7.5 psi. Operating pressure with the boiler observed to be operating between 2.5 psi and 5.0 psi.
   f.

Steam Valve Postion	H_2O Inlet (°C)	Steam Inlet (°C)	Condensate Outlet (°C)	H_2O Outlet (°C)
6:00				
(1 min ave.)	9.2		15.6	
(2 min ave.)	8.5		8.9	
(3 min ave.)	9.5	75.8	9.6	16.6
(4 min ave.)	8.8		7.6	
(5 min ave.)	8.9	77.6	8.2	18
4:30				
(2 min ave.)	8.0	74.8	10.1	24.8
(3 min ave.)			10.6	27
(5 min ave.)	7.9	74.3	10.5	28
(6 min ave.)			10.5	28.1
3:00				
(1 min ave.)	7.8	74.3	18.4	42.7
(2 min ave.)			18.8	42.9
(4 min ave.)	7.8	74.7	17.5	41.1
(5 min ave.)			17.5	41.2
1:30				
(2 min ave.)	7.8	74.7	23.9	47.7
(4 min ave.)			22.5	46.6
(6 min ave.)			22.1	46
(8 min ave.)			21	44.4
(10 min ave.)			21.1	44.3
12:00				
(2 min ave.)	7.8	74.7	19.4	42.3
(4 min ave.)			21.5	44.7
(6 min ave.)			21.1	44.8
(8 min ave.)			20.1	43.9
(10 min ave.)			20	43.7
10:30				
(1 min ave.)	7.8	74.7	22.5	45.9
(3 min ave.)			20.2	45.5
(5 min ave.)			21.3	45.8
9:00				
(2 min ave.)			21.6	44.8
(4 min ave.)	7.8	74.7	21.6	44.6
(6 min ave.)			21.3	43.9
(8 min ave.)			22.3	45.3
7:30				
(2 min ave.)	7.9	75.8	20.2	42.2
(4 min ave.)			20	42.3
(6 min ave.)			21	44.8
(8 min ave.)			21.6	45.3

Overall system stabilized when steam valve was in the 1:30 position with an average condensate temperature of 21.25°C and an average outlet water temperature of 44.7°C.

The condensate receiving separator flowrate limitation was tested with the boiler set at a target of 7.5 psi (actual operation was observed between 5.0 psi and 2.5 psi) based on steam valve positioning to find the following:

- At 1/8 open position on the steam valve, the receiving separator can accept the flowrate.
- At ¼ open on the steam valve, operation is acceptable.
- At 3/8 open on the steam valve, operation is acceptable.
- At ½ open on the steam valve, the oil/water separator inlet is overflowing.

2. June 12, 2007 – Boiler Steam Valve Position vs Condensate Flowrate

A scale and condensate collection container was used to measure the flowrate of the condensate into the receiving separator at two boiler pressure set points.

- At a target boiler pressure of 7.5 psi, steam valve ½ open, overflow is consistently observed. Flowrate measurement averaged 1.74 L/min.
- At a target boiler pressure of 5.0 psi, steam valve ¾ open, overflow is inconsistently observed. Flowrate measurement averaged 1.56 L/min.
- Steam valve increased to 7/8 open, overflow is consistently observed. Flowrate in excess of 1.6 L/min.

In light of the results it is recommend the system operate at a condensate flowrate no more than 1.5 L/min.

3. June 13, 2007 – Foliage Essential Oil Extractor Test Run

System set points:

- Boiler Pressure 5.0 psi.
- Steam Valve opening ½ open.
- Cold Water inlet to the Condenser was wide open.

Observations:

- Foliage tank has a pinhole leak on the bottom seam. Using the reference of the rear of the trailer being to the west, the leak is located on the SW side of the bottom seam on the vessel.
- Foliage tank gaskets are leaking. It appears the glue is not heat resistant to 100°C.
- Water is collecting in the bottom of the foliage tank and it required draining. There appeared to be oil in this water.
- Receiving Separator could not overcome the line head when a garden hose was connected to the separator outlet. As soon as the garden hose was disconnected, the receiving separator had no overflow problems.